ENGINEERING

An Illustrated Weekly Journal.

EDITED BY CHARLES COOPER AND J. FOSTER PETREE.

35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2. TELEPHONE: TEMPLE BAR 3662.

VOL. 176.—No. 4568. LONDON: FRIDAY, AUGUST 14, 1953. Price 2s.

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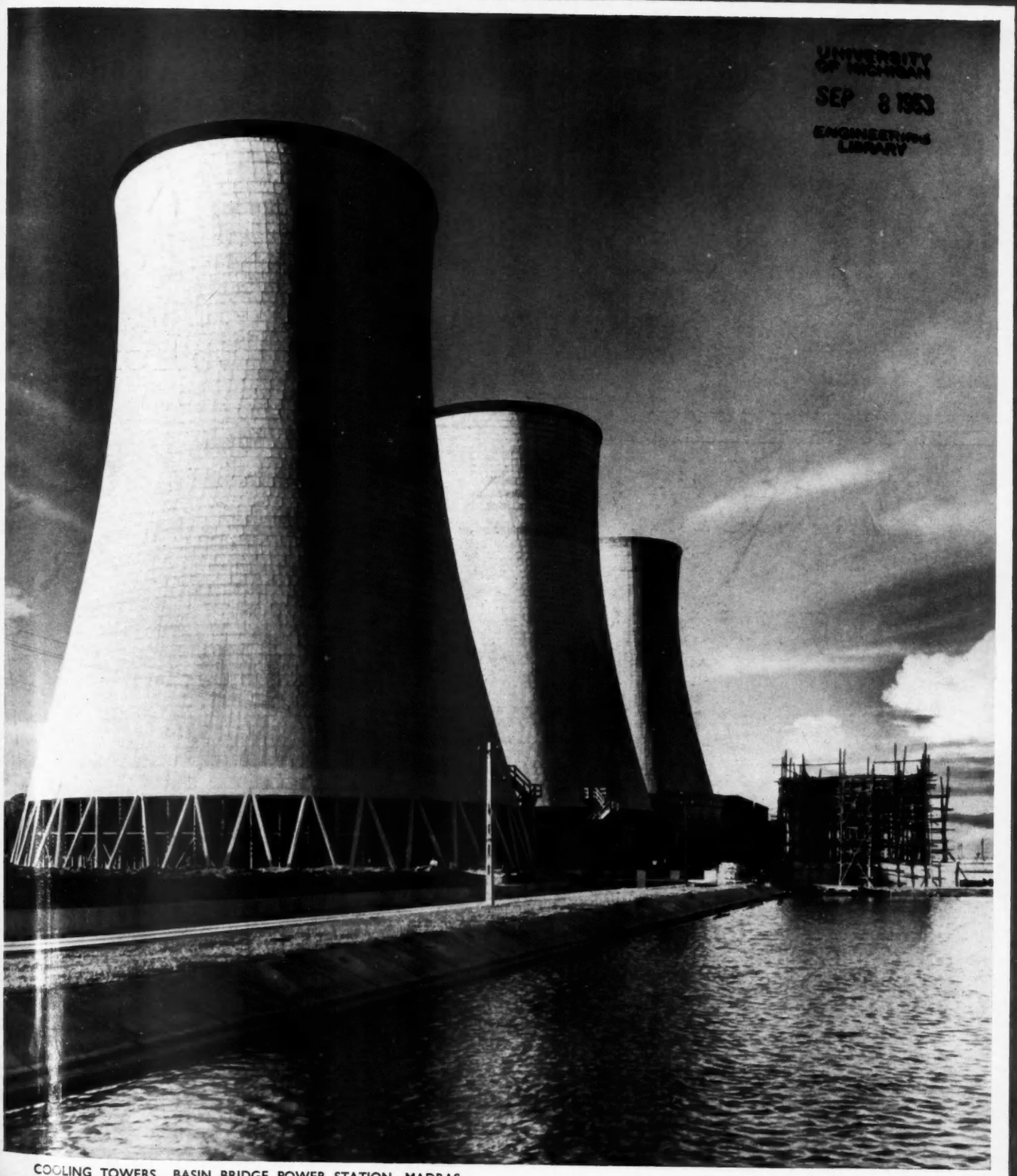

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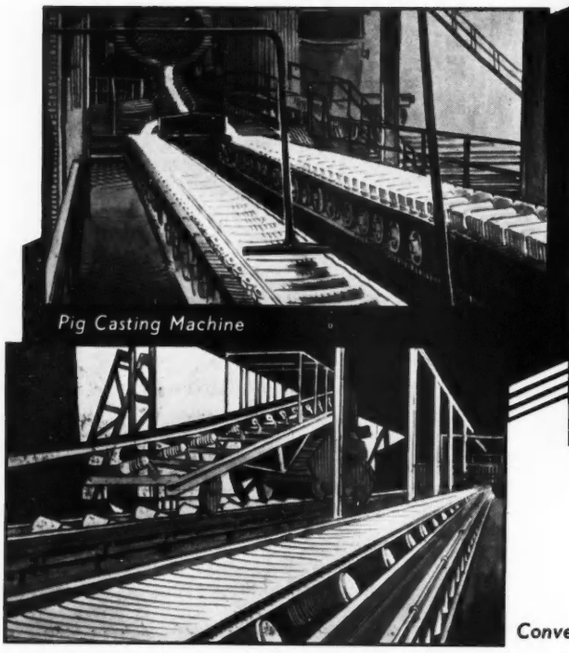

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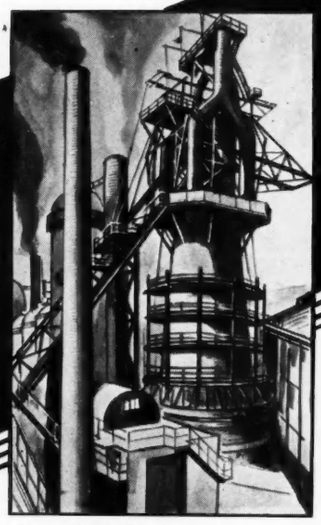

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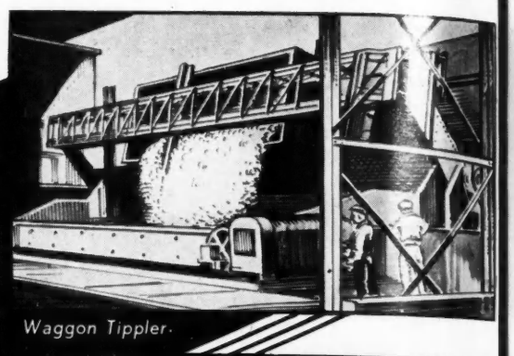

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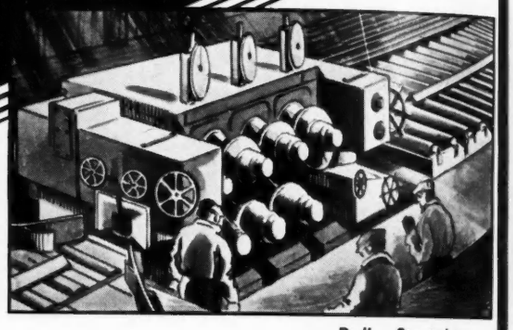

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THE MANUFACTURE AND MANIPULATION OF SEAMLESS TUBES: MESSRS. ACCLES AND POLLOCK, LIMITED.—II.*

WHEN Accles and Pollock, Limited, moved to Oldbury 50 years ago, it was said that the only uses for tubes, other than as containers and transporters of fluids, were in bicycles and bedsteads. In these two cases, tubes were employed as structural members because they combined strength with lightness. The use of tubes has developed along these lines, particular impetus being given to the development by the aircraft industry; but it has also become common practice to use a tube in many cases where formerly a component was machined from the solid, for the obvious reason that machining costs are reduced by so doing. To-day, tubes have so many uses that large sections of the Oldbury works are occupied with manipulating, machining, shaping and finishing them to meet numerous requirements.

The work of tube manipulation at the Oldbury works can be divided, roughly, into two main categories, namely, the production of complete components such as the aero-engine mounting shown in Fig. 1, herewith, and the preparation of the tubes in the many forms necessary for making such components. Many of the components require, in their essentials, only straightforward fabrication, but in most instances, especially in the case of aircraft work, the permitted tolerances are very small. With a welded component, such as that illustrated in Fig. 1, the existence of close tolerances on both the machined and the unmachined dimensions means that the risk of distortion during welding has to be watched very closely. Both electric and oxy-acetylene welding are in regular use, and in both cases careful planning of the welding sequence is necessary to prevent distortion. The planning depends, to some extent, on experience and experiment; the behaviour of the components during welding, and after release from the welding fixtures, cannot always be forecast with accuracy. In the machining of fabricated components, orthodox machine tools, jigs and fixtures are used, and normal machine-shop practice is followed. Fig. 2, herewith, shows a typical machining operation, the pads on aircraft engine-mounting rings being faced on Cincinnati vertical milling machines.

Many of the tubes needed for the manufacture of fabricated components require special preparation. This work is done at Oldbury, together with much similar work on tubes and tubular parts for customers who undertake their own fabrication. The operations include bending and coiling, expanding and reducing, tapering, butting—that is, producing tubes with more than one diameter in the bore; bulging, doming and beading; slitting and piercing; and all the various machining and finishing operations which are normally carried out on solid components. These latter operations include drilling, turning, screwing, broaching, polishing, and lapping. Bending is the commonest process to which a tube is subjected, and may range from slight bending, over a few degrees only, to continuous coiling. Bending is still carried out in some cases by the familiar method of filling the tube with resin, sand or other material, and then bending it round a former of the desired radius; but most of the bends now made are done on automatic bending machines which support the tube with a plug inserted in the bore.

The plug, which is somewhat similar to that used in plug drawing, is held in the bore of the tube by a bar, at the point where the bend takes place, and the tube is drawn away from it round a former by hydraulic or mechanical power. Articulated plugs, which pass into the bend and are later withdrawn from it, are also used in some cases. The automatic bender is particularly applicable to such work as the production of vehicle or stacking seat frames, where the quantities required are large. Tube bending is basically a simple operation, but in practice much depends upon the material specification and the relationship between diameter and wall thickness, and standard rules covering the whole process cannot be laid down. Experience has shown that, where the wall thickness is less than one-fifteenth of the tube diameter, a rough equation can be used to determine the limiting radius at the centre line of a bend. This equation is $R = \frac{D^2}{10T}$, where R = radius to the centre line, D = outside diameter of the tube, and T = wall thickness. The equation is useful as a general guide to possibilities, but, in certain circumstances, bends can be made which are sharper than calculation indicates to be possible. The real limit is dependent upon the particular conditions, and in the Oldbury works individual cases are treated on their merits.

Expanding or reducing a part of a tube is carried out by pressing the end of it on to a suitable mandrel, or into a die of the desired shape; but bulging at some part away from the ends is achieved by using hydraulic pressure inside the tube to force it into a split die. Butting, which is the production of a tube with more than one internal diameter, while the outside diameter remains constant, is used where extra strength is needed at a particular point or points. An example of this can be found in a 'bus or coach seat frame. The tube from which the frame is made is butted so that the thickness is greater at the point where the bend carrying the maximum stress will come. The strength is thus increased only at the point where it is needed, and the weight of the component is kept to a minimum. The external appearance of the tube, since only the internal diameter is affected, is that of a normal tube with parallel walls. Butting is done by pushing or pulling the tube on a mandrel and through a die, the mandrel being of the size and shape required in the finished bore.

A horizontal hydraulic press, shown in Fig. 3, on page 194, is used for the operation of butting. The production of a butted tube having two internal diameters, where the mandrel can be withdrawn through the larger one, or having a central portion which is smaller in diameter than the ends, in which case the mandrel can be removed from either end, is relatively simple. Double-butted tubes are produced, however, in which the wall thickness at each end is greater than that in the middle. This is also done by passing the tube on a mandrel through a die. It would appear, at first sight, impossible to extract the mandrel, but this is done by expanding the tube until the mandrel can be withdrawn, and then "sinking" or otherwise reducing it to the original outside diameter. Tubes with tapering gauges are also produced by butting; large quantities of these tubes are used by the aircraft industry. Taper tubes with a constant wall thickness are also made, in which case the taper is produced by one of two methods. In the first, the tube is tapered by rolling it between rolls which have the required taper cut on their peripheries. The rolling is intermittent, the tube being fed forward into the rolls in a series of steps. In the second case, the tapering is done by means of dies on a rotary swaging machine. By using the appropriate method, tubes can be produced with

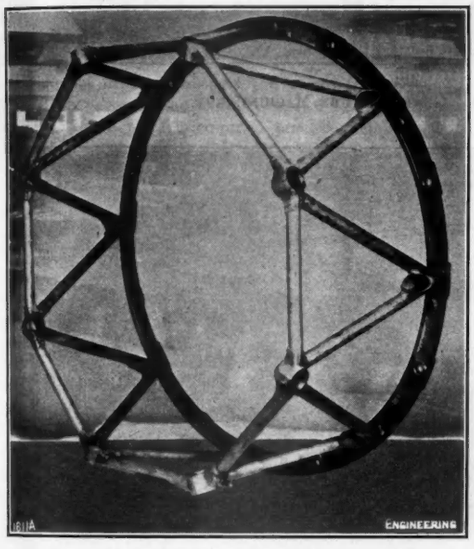


FIG. 1. WELDED TUBULAR AERO-ENGINE MOUNTING.

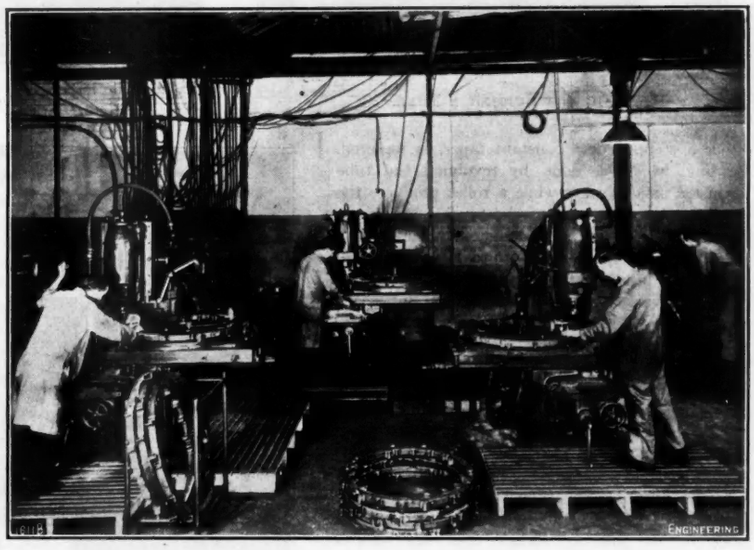


FIG. 2. MACHINING PADS ON WELDED ENGINE-MOUNTING RINGS.

* Part I appeared on page 161, *ante*.

MANIPULATION OF SEAMLESS TUBES.

Fig. 3. Butting a Tube.

Fig. 4. General Tube Machining.

either a stepped or a constant taper, as required. Beading, which is done by revolving the tube against a small former while a roller produces the bead, in the same way as sheet-metal beading is done, calls for no particular comment. The familiar vacuum-cleaner extension tube usually has a typical example of beading at the end. Slotting, which is done for a variety of purposes, is carried out in one of two ways. In cases where the internal diameter of the tube is large enough, a special slotting tool, having the appropriate number of punches, is inserted in the bore, and the punches are then forced outwards by a tapered plug or wedge, which causes them to cut all the slots simultaneously. Alternatively, where the bore of the tube being slotted is small, a light power-press is used, with an indexing fixture. The tube is placed in position, and a slot is cut. This slot is then used as a location point on the indexing fixture, and the tube is indexed round until all the slots have been cut.

For the machining of tubes, internally or externally, there are several machine shops at the two Oldbury works. Fig. 4, on this page, shows a typical shop. External machining is dealt with on batteries of turret, capstan and centre lathes (Fig. 5); all the normal turning operations are within the scope of this department. Centreless grinders, illustrated in Fig. 6, are also provided, and there is the usual drilling equipment, both of the single-spindle and the radial types. Tubes can be polished, both internally and externally, internal polishing being possible down to a bore of about $\frac{1}{2}$ in. diameter; this process is applied particularly to the stainless-steel range of tubes, especially when they are to be used in the food or chemical industries.

For aircraft work, oleo tubes, and similar hydraulic applications, tubes are supplied honed internally, facilities being available for dealing with tubes up to 6 in. diameter and 16 ft. long. Two types of machine are used for honing. One is a horizontal machine made by Brookes (Oldbury), Limited, and illustrated in Fig. 9, on page 208; it has two spindles, which are reciprocated, fed forward, and withdrawn, by hydraulic power. The other type of machine used for honing is the American Barnesdrill, which is also hydraulic, but is vertical and has a single spindle (Fig. 8, page 208).

The work done on the finishing of tubes for aircraft and similar applications is to very close limits. External grinding, for example, is done to limits of $\pm 0{\cdot}00025$ in. or even closer, and the bores of

Fig. 5. Lathe Shop.

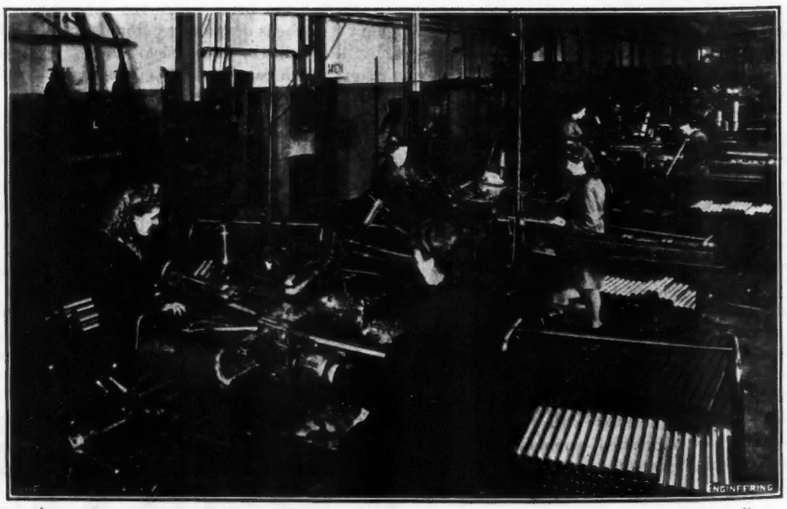


Fig. 6. Centreless Grinders.

tubes can be finished to almost as great a degree of accuracy, with a surface finish to within 6 micro-inches. The machining of tubes to close limits is always a matter of some difficulty, which varies according to the material specification but invariably increases as the wall thickness decreases. Working to the limits mentioned is largely a matter of holding the tube truly circular while machining it, and very great care has to be given to the design and use of the fixtures employed, if ovality is to be avoided. Another difficulty which arises is when tubes are required to be machined at the ends to take either inside or outside fittings. The tube is inherently springy, and, though it is held truly circular while being machined, it may become slightly oval on release. The solution to this problem, if it is undesirable or impossible to increase the wall thickness sufficiently to give the necessary rigidity, is to hold the tube truly circular again while the end fittings are placed in position. Screw-cutting on light-gauge tubes, especially if they are hard-drawn or have a blued finish, may also prove difficult, in the same way as plain machining. Here, again proper support is the answer to the problem, the tube being held by a sleeve or plug, according to whether the thread is on the inside or outside.

Numerous other operations are regularly performed on tubes at the Oldbury works. Shaping under a power press is common practice—simple bending is often done in this way—but flattening and piercing are more orthodox uses for the press. A typical operation in this category is the preparation of the ends of seat frames, and the piercing of screw holes in the prepared ends. The frames are bent to shape in an automatic bending machine, and are then passed to a light power-press of the normal crank type. Two tools are set up in the press, one for flattening the ends of the frames, and the other for hole piercing. The operator uses the tools alternately.

An operation which is of interest, both as regards the equipment used and because it is a production job on a very large scale, is the manufacture of box spanners. Short lengths of tube of the required diameter are placed by an operator so that one end is over a plug of the correct hexagon shape and size. Six flat-ended punches or forming tools are mounted round the plug in a ring-shaped holder, and are spring-loaded to stand clear of the plug while the tubular blank is placed in position. The outer ends of the forming tools are set at an angle, and match the inner surface of a tapered collar. When the collar is drawn along in the direction of the centre-line of the plug and tube, the forming tools are forced inward, and, making contact with the tube, press it on to the plug, so producing the required hexagon. The tapered collar is then returned to its starting position, so releasing the forming tools, which open outwards and enable the operator to remove the formed spanner and to place a fresh blank in position. Fig. 10, on page 208, illustrates the spanner-forming machine, which, by different tooling, can also be used to produce squares, as, for example, on carburettor-jet spanners.

BUSINESS EFFICIENCY EXHIBITION, CARDIFF.—A regional business-efficiency exhibition has been arranged by the Office Appliance and Business Equipment Trades Association, 11-13, Dowgate-hill, Cannon-street, London, E.C.4. This exhibition, in which some 50 firms have arranged to take space, will be held at the Drill Hall, Dumfries-place, Cardiff, from Monday, September 14, to Thursday, September 17, 1953.

PARMITER, HOPE AND SUGDEN LTD.—A small illustrated booklet, giving an introduction to the firm, its history, its manufactures, and the opportunities afforded to employees for training and advancement, has been issued by Parmiter, Hope and Sugden Ltd., Fluvent Electrical Works, Longsight, Manchester 12, under the title *Working for Fluvent*. A short section on apprenticeship with the company, which makes electrical distribution gear for industrial plant, house service fuses, and main distribution fusegear for the electricity-supply industry, is included.

LITERATURE.

Engineering and Western Civilization.

By PROFESSOR JAMES KIP FINCH. McGraw-Hill Book Company, Incorporated, 330, West 42nd-street, New York 36, New York, U.S.A. [Price 5·50 dols.]; and McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4. [Price 47s.]

GENERALLY speaking, American books on the history of engineering tend to be rather one-sided, in that they seldom give as much attention to European pioneer work in engineering development as the facts really warrant. It is a pleasure, therefore, to welcome in this volume a review that is at once comprehensive and notably well balanced; though that is only what might be expected from the Dean Emeritus of the School of Engineering at Columbia University. This is no mere compilation of historical commentaries, however well authenticated; it is the thoughtful survey of a philosopher, thoroughly grounded in his subject and widely read in its literature, who is also a sound engineer with all of a real engineer's urge to get at the facts of what he is studying. Professor Finch has already written extensively on engineering history, as witness his biographies of *Early Columbia Engineers* and various articles and papers, but, so far as we are aware, has not produced before anything which covers such a wide field as the present book.

To attempt to summarise in any detail the 21 chapters which constitute the main text is neither practicable nor necessary. In the first six of them, the author ranges from the engineering of ancient Egypt, Greece and Rome, through the Middle Ages and on to the French; British and American engineering (in that order) of the Seventeenth, Eighteenth and Nineteenth Centuries. With Chapter 7, "The New Engineering," he enters upon his principal theme of the rise of engineering science, which he proceeds to discuss in more detail in the succeeding six chapters on various aspects of modern engineering—transport, materials, power, etc., summing up and analysing them in Chapter 14. From this it is a logical step to the two chapters on "Engineering and Economic Change," after which the historian merges more completely into the philosopher with studies of "Engineering and the Worker," "The Distribution of Technological Gains"—a chapter which deserves to be widely read for the completely dispassionate arguments which lead to the conclusion that "organised pressure activities of any kind" in industry "must ultimately be curbed" if economic progress is not to be disrupted—and "Technological Change and Capital Goods," in which productive capacity, obsolescence and replacement are discussed. Finally, there is a chapter on "Engineering and Research," in which a comparison is clearly made between organised teamwork and "the efforts of the inspired individual worker," and their respective economic possibilities and results; and a "Conclusion" which discusses the bearing of all this engineering and scientific development on democracy and progress.

With many books, it is sufficient to end a review with a mere note of the fact that they contain also a bibliography and an index. Of the index, in the present instance, we need only mention that it is there, and is adequate; but the bibliography warrants something more. It is arranged according to the chapters of the book, which is a good feature, though one that may prove difficult to maintain without undue repetition of references; but its particular merit is that it is annotated so as to form a really useful guide to further reading. It is not exhaustive—for instance, marine engineering is dismissed very briefly, and, while Francis Trevithick's *Life of Richard Trevithick* is mentioned, the centenary volume, *Richard Trevithick, The Engineer and the Man*, by H. W. Dickinson and Arthur Titley, is not; but it is obviously the result of actual reading, and those who are guided by it will find most of the missing references for themselves.

That the book is excellently produced goes without saying, though there are a few misprints; for example, the familiar mis-spelling of Henry Maudslay's name as "Maudsley," and "double-brick" instead of "double-track," at the top of page 58, in the reference to Brunel's tunnel under the Thames. A surprising omission, however, is the absence of any reference to the tilting-pad thrust bearing, either in connection with the name of Michell or of Kingsbury; an omission that is the more curious in that, apart from its outstanding influence on the development of marine machinery, it has the distinction, like the pneumatic hammer, of being one of the few engineering devices that have undergone no material change since their introduction.

Thermodynamique.

By PROFESSOR Y. ROCARD. Masson et Cie., 120, Boulevard Saint-Germain, Paris, 6e. [Price 3,650 francs in paper covers; 4,150 francs cloth-bound.]

PROFESSOR ROCARD has followed his treatise on electricity, published little more than two years ago and reviewed in our issue of May 18, 1951 (vol. 171, page 585), with this comprehensive treatise on thermodynamics, divided into seven sections and covering 540 pages. It begins with an account of classical thermodynamics which includes not only all the more usual illustrations of the applications of the principles to thermo-elastic properties, cells, osmotic pressure and capillarity, but discusses also the thermodynamics of superconductors, magnetic effects such as the production of low temperatures by adiabatic demagnetisation, and electrostriction. This first section ends with a chapter on the Nernst heat theorem and its verification. Section II is concerned with the thermodynamic properties of matter and contains chapters on the mechanical properties of fluids, the Joule-Kelvin expansion and its applications, the specific heats of condensed fluids, condensed states of the same substance in equilibrium, binary systems, and an account of the singular properties of liquid helium. The next section, on "Technical Thermodynamics," will be of particular interest to engineers, for not only does it deal with steam and internal-combustion cycles and the steam turbine, but also with the operating principles of gas turbines and jet propulsion. The chapter on refrigeration and the liquefaction of gases includes an ingenious method, proposed by Hilsch in 1947, using the expansion of gases in a centrifugal field as a cooling process. It is followed by one on explosives and another on the possibilities of nuclear energy, in which an outline of the calculation of the critical size of a pile is given. Part IV opens with an account of the thermodynamics of radiation and then treats equilibria involving the annihilation or creation of matter or radiation, and the cosmogonic theories of Gamow and Hoyle. This serves to introduce a survey of the thermodynamics of the stars and the nuclear-reaction cycles that have been proposed to account for stellar evolution.

The authoritative character of the exposition of the kinetic theory which occupies Part V is largely due to Professor Rocard's own considerable contributions to the subject. After a discussion of Maxwell's velocity-distribution law and its consequences come sections on the stability of planetary atmospheres and on Knudsen's work on rarefied gases, which is fundamental in vacuum practice. Transfer phenomena are considered next, together with the kinetic theory of shock waves, and Brownian movement. A new kinetic theory of surface tension is proposed and the detailed discussion of equations of state is confined to such as have a rational theoretical basis. Statistical

MACHINE FOR MEASURING LOAD AND DEFORMATION OF RUBBER.

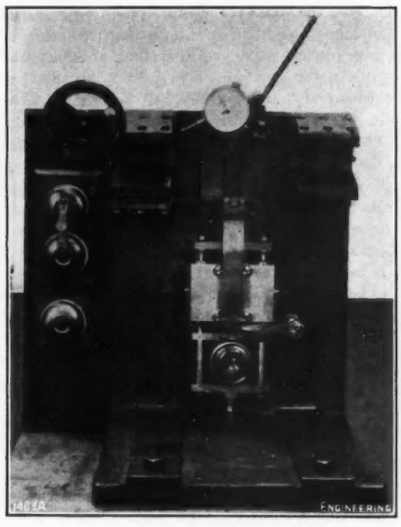


Fig. 1. Early Form of Machine.

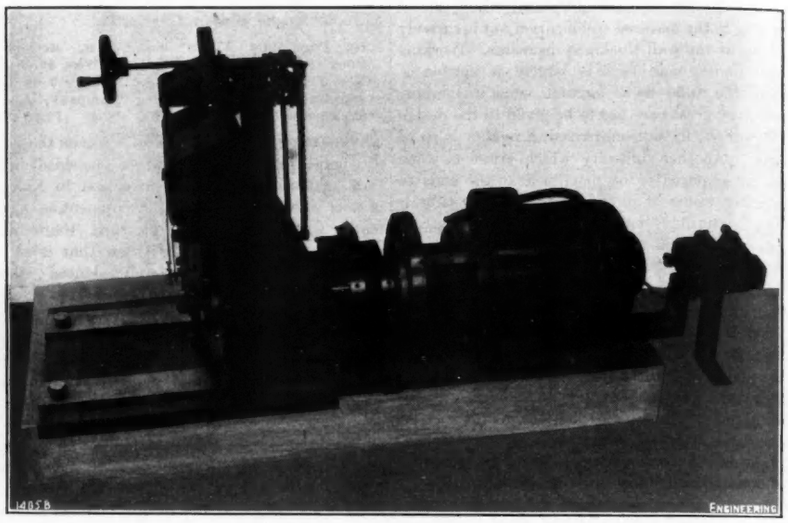


Fig. 2. Side View of Machine.

fluctuations in temperature and density are then critically examined, and the author's theory of diffusion of light is followed by a paragraph on the diffraction of X-rays by liquids in which an error in Raman's reasoning is pointed out. This part ends with chapters on the modern theory of solids and on long-chain molecules.

Part VI, devoted to statistical mechanics, begins with an analysis of the classical statistics of Maxwell and Boltzmann and a formulation of the alternative statistics of Bose and Einstein, and Fermi and Dirac. An outline is given of the theory of fusion developed by Lennard Jones and Devonshire, and of order and disorder in alloys. A chapter on the Einstein-Debye theory of specific heats is followed by two chapters on the Bose-Einstein and Fermi-Dirac gas, with sections on degeneracy, liquid helium and thermionic emission. The first chapter of Part VII deals with the transfer of heat and, in particular, with the conduction of heat, though the Lees disc method of determining thermal conductivity is not mentioned. The second chapter is concerned with irreversible phenomena and the important contributions made by Onsager to the understanding of them. The concluding section contains a specification of units and a selection of numerical data. There is an index as well as a table of contents.

Comparatively few misprints were noted, but both formulæ for temperature conversion on page 532 are incorrect. The exceptionally broad view that Professor Rocard has taken of the scope of thermodynamics, the large amount of recent material (there are several references to work published in 1951) incorporated in his exposition, and the enthusiasm and mastery of his treatment all contribute to make this handsome volume a valuable text for the graduate and post-graduate student.

Taxicabs with Diesel Engines.—Tests carried out with London taxicabs have shown that substantial savings in fuel costs can be made at the present time by fitting Diesel engines in place of petrol engines. F. Perkins, Ltd., Peterborough, who are now producing their P4 type of Diesel engine for installing in existing Austin and Morris taxicabs, report that the tests have shown that the fuel-oil consumption is 30 miles per gallon (in some cases 34 m.p.g.), compared with 17 m.p.g. for a petrol-engined cab. With petrol at 4*s.* 3½*d.* per gallon and fuel oil at 3*s.* 11½*d.*, the cost per mile is thus 3*d.* for the petrol taxi and 1·58*d.* for the Diesel. With these relative costs, and on a cab which covers 50,000 miles in a year, the cost of conversion is more than paid for within a year.

Fig. 3.

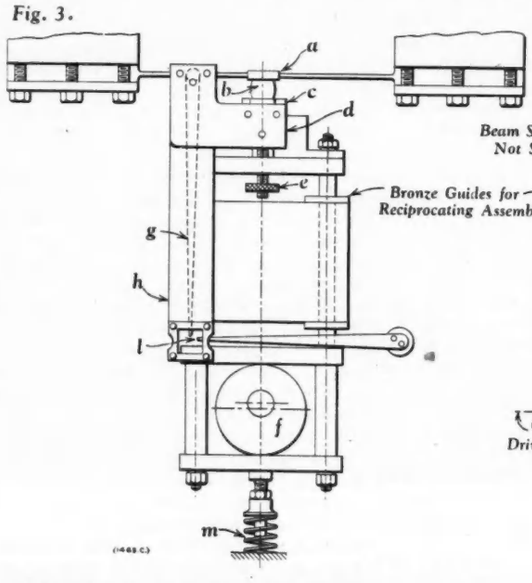
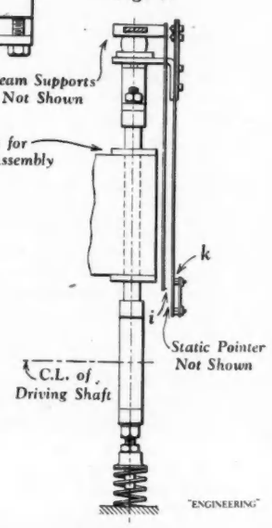


Fig. 4.



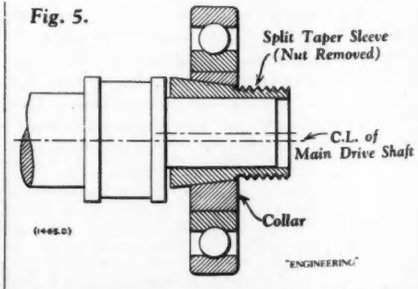
MACHINE FOR MEASURING LOAD AND DEFORMATION OF RUBBER UNDER CYCLICAL COMPRESSION.

By D. M. Davies.

With the increasing use of rubber as an engineering material there has been a growing demand for a fuller knowledge of its mechanical properties. Being a visco-elastic material, its properties are affected very considerably by such parameters as temperature and rate of stressing, or frequency in the case of cyclical stressing. For purposes of engineering design a knowledge of the variation of the mechanical properties of rubber with these parameters is essential. The nature of the material makes existing testing machines and techniques unsuitable, and new methods are often necessary.

The method most widely used in the past to investigate the behaviour of rubber under cyclical stressing is based on observations of the resonant frequency and amplitude of a forced vibration applied to a rubber specimen. It is generally agreed, however, that this method has some rather serious shortcomings, and the need has long been felt for a more direct method of testing. The most direct method would be to record the transient force-deformation relationship for a rubber specimen over one complete cycle. Such a method was developed by Roelig* in Germany. In his machine a cyclical force is applied to a compression specimen by a rotating eccentric mass, the eccentricity of

Fig. 5.



* Dynamic Evaluation of Damping and Durability of Rubber Compounds," by H. Roelig. *Proc. Rubber Tech. Conf.*, Paper No. 62, page 821 (1938).

MACHINE FOR MEASURING LOAD AND DEFORMATION OF RUBBER.

Fig. 6. VARIATION OF STIFFNESS WITH AMPLITUDE.

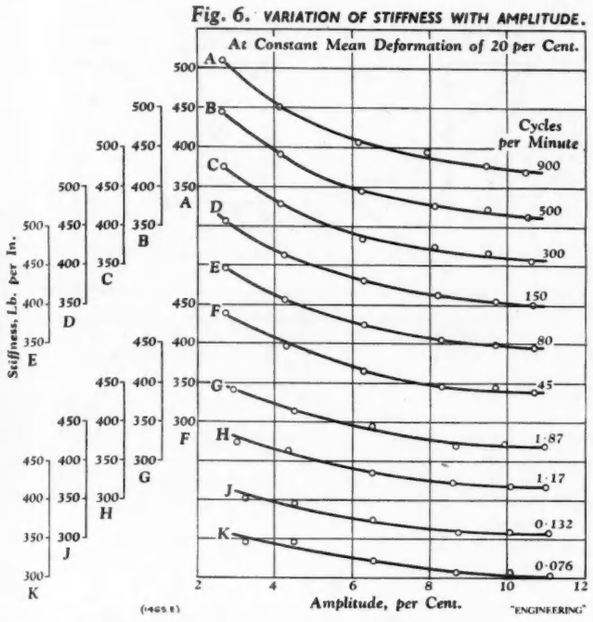
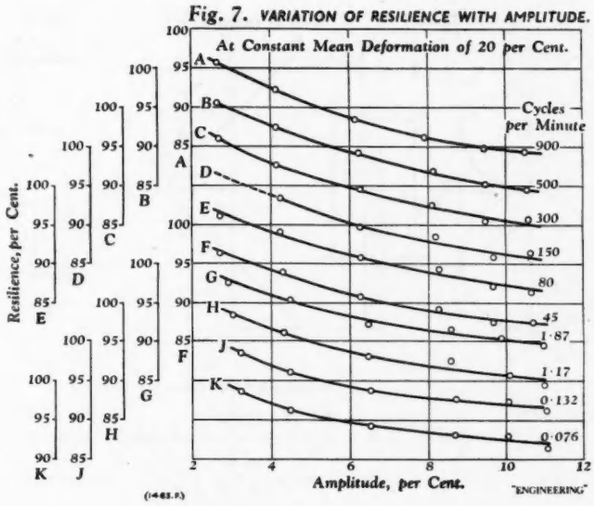


Fig. 7. VARIATION OF RESILIENCE WITH AMPLITUDE.



which can be varied while the machine is running. Force and deformation are recorded optically by the angular displacement of two mirrors whose axes are at right-angles. The movement of one mirror is proportional to the force on the specimen and that of the other to the deformation of the specimen. A spot of light is reflected from one mirror on to the other and then on to a screen to give a force-deformation record. Similar machines have been installed in this country and in the United States, but it is understood that some trouble is experienced with the wandering of the image due to the vibration of the machine.

In a programme of research at the University of Nottingham, a machine was required with an unlimited low-frequency range. The Roelig machine was ruled out on this score alone, so a new machine was developed, and was made in the workshop of the University Engineering Department. Figs. 1 to 4 show the essential features of the machine. The lower platen *c*, on which the specimen *b* rests, forms part of a reciprocating assembly driven by the eccentric *f*. The top of the specimen bears against the underside of an encastré beam *a* of spring steel. When the lower platen rises, the specimen is deformed by a force which is proportional to the consequent displacement of the beam. This displacement is converted into a proportionate and approximately horizontal movement of the scribing point *i*, at the lower end of the light-weight pointer *g* rigidly attached to the beam near its point of contraflexure. A piece of smoked glass *k*, on which the scriber ultimately records, is housed at the lower end of a thin leaf spring *h* rigidly attached at its upper end to the bracket *d* carried by the lower platen. The relative vertical displacement between the scribing point and the screen is thus a measure of the axial deformation of the specimen (see remarks on axes below), while the relative horizontal displacement is proportional to the force on the specimen. Thus a miniature autographic record of force against deformation is obtained which can subsequently be enlarged by projection.

This method of magnification does away with the inertia and friction troubles which are associated with moving mirrors or linkages. The purpose of the leaf spring *h* is to enable records to be taken only when desired. Normally, the smoked glass is clear of the scribing point, and a record is only obtained when they are brought into contact. This is achieved by manual deflection of the spring strip. Fig. 1 shows a front view of the machine at an earlier stage of development when a cantilever was used in place of the encastré beam to measure force. The recording pointer was then attached at the free end of the cantilever, and the scribing point itself can be seen through the square "window" in the leaf spring, which normally carries the smoked-glass slide. A special technique, which gives exceptionally good records for purposes of magnification, is used in preparing the slides.* The essential feature of this technique is that, after smoking the glass fairly lightly, paraffin is allowed to trickle over the smoked face by capillary action.

Fig. 2 shows a side view of the machine. The main driving motor is a ½-h.p. direct-current machine with potentiometer control to give an effective speed range of 40 to 1,500 r.p.m. The potentiometer control is mounted on a panel beside the main casting and can be seen in Figs. 1 and 2. A small 24-volt motor is used for speeds below the range of the main motor. This small motor is arranged to give a direct drive on to a projection from the tail end of the main motor shaft. The bracket carrying this 24-volt motor (Fig. 2) is so designed that it can be slid back in order to disengage this slow-speed drive when the main motor is in operation. For even lower speeds, a second of these 24-volt motors provides a friction drive on to the flywheel on the main motor shaft. The motor can be seen on the far side of the flywheel in Fig. 2, and in the foreground is the tension spring which maintains the friction drive. This drive, which permits cycles to be run at the rate of one in about 30 minutes, can again be engaged and disengaged very readily.

In order to determine the axes, the machine is turned by hand, first without a specimen to give a line of zero force, i.e. "the deformation axis," and then with a steel ball fitted in place of a specimen to give a line of zero deformation, i.e., the "force axis." To produce axes and a hysteresis loop on every slide would be very tedious, necessitating repeated removal and replacement of the specimen. A technique was therefore developed whereby the axes need be recorded on one slide only. For this purpose a static pointer *l* (Fig. 3) was fitted to the machine. This static pointer scribes a vertical reference line on each slide, including the slide showing the axes. When the slides are projected and traced, in turn, they can be orientated with respect to each other simply by matching up the reference lines. In this way any loop can be placed in its correct position relative to its axes. Magnifications of the order of × 60 have been used for projection.

A vertical ordinate as recorded by the machine is really the relative vertical displacement between the lower platen and the point of contraflexure of the beam, since the smoked-glass slide is attached to the former and the scribing point to the latter. This ordinate exceeds the axial deformation of the specimen by an amount equal to the difference in height between the centre of the beam and its point of contraflexure. This difference is proportional to the applied load, so that, by inclining the force axis at the appropriate angle, the record can be presented as one of force against deformation. The inclination of the force axis is automatically taken care of by the method described above. If necessary the machine can be made to record force against deformation on rectangular axes by turning the pointer *g* through the requisite angle.

Details of the eccentric drive are shown in Fig. 5. The front end of the main drive shaft is eccentric to the extent of $\frac{1}{16}$ in., and carries an eccentric collar held in position by means of a split taper sleeve. The collar, which is also eccentric by $\frac{1}{16}$ in., can thus be locked in any angular position relative to the shaft, so that the overall eccentricity can be varied from zero up to $\frac{1}{8}$ in. A ball bearing is included between the eccentric and the yoke of the reciprocating assembly. The inner race is a force fit on the eccentric collar, and the outer race a sliding fit in the yoke.

To provide for variation of the mean deformation of the specimen during any cycle the lower platen can be raised and lowered by means of the knurled nut *e* (Fig. 3). The purpose of the spring *m* is to smooth out any cyclical speed variations.

An investigation into the effect of frequency on the behaviour of rubber has already been carried out on this machine.* The effect of amplitude is shown in Figs. 6 and 7 for a rubber of specification CS.2507, containing 60 parts by weight of lamp-black to 100 of rubber. Cylindrical specimens were used of diameter ½ in. and height ½ in. Stiffness, as plotted in Fig. 6, is the slope of a line joining the ends of the hysteresis loop. The loops in question were sufficiently pointed at their ends to avoid any

* "High Resolution Recording with Soot," by K. R. Eldredge. *Rev. Sci. Instr.*, vol. 21, No. 3 (1950).

* "The Effect of Frequency on the Behaviour of Rubber Under Cyclical Deformation," by D. M. Davies. *Brit. Jl. App. Phys.*, vol. 3, No. 9, page 285 (1952).

VELOCITY RATIOS OF EPICYCLIC GEARS.

Fig. 1.

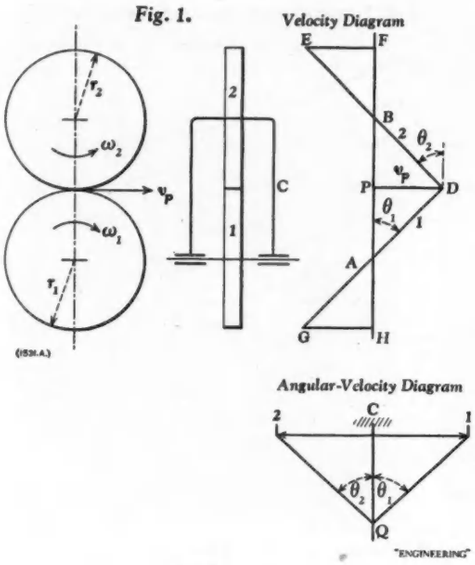
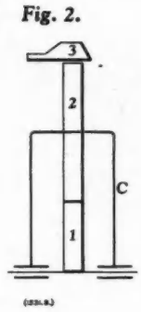
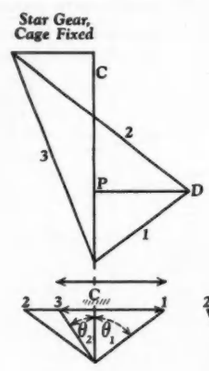
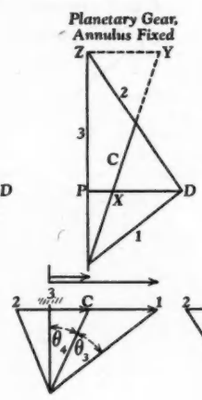


Fig. 2.







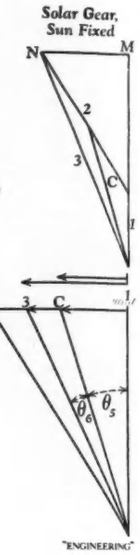


Fig. 3.

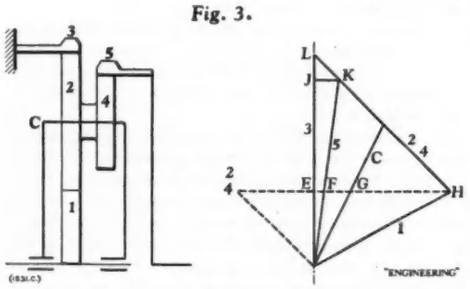
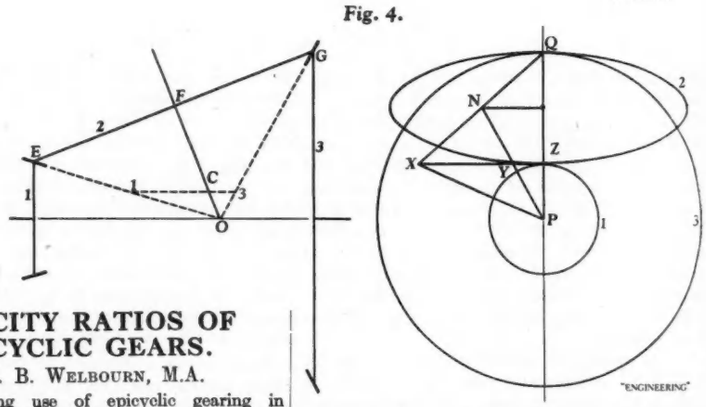


Fig. 4.



ambiguity in the choice of such a line. The term resilience in rubber technology has a somewhat different meaning from that given to it by engineers generally. Resilience is here defined as the ratio of energy returned to energy put in during one complete cycle, and was calculated directly from the recorded hysteresis loops by means of a planimeter. The dependence of resilience on amplitude makes the use of a rebound pendulum for measuring resilience fundamentally unsound. For industrial purposes, however, the rebound pendulum is a most attractive instrument.

Electronics Course at Harwell.—The seventh specialised course on the design, use and maintenance of electronic instruments used in nuclear physics, radio-chemistry, and work with radio-isotopes will be held at the Isotope School, Atomic Energy Research Establishment, Harwell, from Monday, September 28, to Friday, October 2, 1953. There will be lectures and practical work on counters, amplifiers, coincidence units, scalers, and rate meters, by specialists at the Establishment. The fee for the course will be 12 guineas and living accommodation, transport and meals will be provided at a charge of 7 guineas. Applications should be made, not later than September 11, to the Electronics Division, Atomic Energy Research Establishment, Harwell, near Didcot,

International Engineers' Congress, Italy.—The First International Engineers' Congress in Italy will be held at the Termini Station Buildings, Via Giolitti, Rome, from Thursday, October 8, to Sunday, October 11, 1953, both dates inclusive. The congress is being organised under the auspices of the Fédération Internationale des Associations Nationales d'Ingénieurs and will have as its main theme "The Preparation of the Engineer for His Place in Society." Arrangements are being made for a number of tours to industrial establishments and places of interest to take place during the four days following the conclusion of the congress. Further particulars are obtainable from the congress secretariat, Associazione Nazionale Ingegneri ed Architetti Italiani, 90, Via Terme Diocleziano, Rome

VELOCITY RATIOS OF EPICYCLIC GEARS.

By D. B. Welbourn, M.A.

The increasing use of epicyclic gearing in industrial and marine machinery has resulted in a larger number of engineers than heretofore wishing to be able to calculate easily and quickly the velocity ratios and pitch-line velocities of such gears. It appears that the following very simple method due to Beyer* and Kutzbach† has not so far received the attention it deserves except on the Continent.

Simple Epicyclic Gears.

The basic principle on which their graphical and semi-graphical method is founded may best be illustrated by consideration of the train shown in Fig. 1. Two diagrams of the gears are shown, wheel 2 being mounted on a cage C. In addition, for the case when the cage is fixed, a form of velocity diagram is drawn, such that departures from the vertical line HF represent the linear velocities of points on the centre-line of the gears. On this diagram PD represents v_p, the pitch-line velocity. Clearly, the centres of the gears represented by A and B have no velocities, and the outer edges have velocities represented in magnitude and direction by EF and GH. In general, points on GD give the velocities of points on wheel 1, points on DE those of wheel 2; and points on HF those of the cage, which are obviously always zero.

It is seen that

$$\tan\theta_1 = \frac{PD}{AP} = \frac{v_p}{AP} = \frac{\omega_1 r_1}{r_1} = \omega_1.$$

If we now draw a new diagram as shown, taking a pole Q such that CQ is equal to unity, we can obtain an angular-velocity diagram by drawing Q 1 parallel to AD and Q 2 parallel to BD.

Thus $C1 = \tan\theta_1 = \omega_1$, $C2 = \tan\theta_2 = \omega_2$, and, with the cage fixed, these lines represent the angular velocities both in magnitude and direction. Obviously, in this simple train the angular-velocity ratio is unity, and the direction of rotation is reversed.

In Fig. 2, an annulus has been added to the train, and velocity and angular-velocity diagrams are drawn for the three possible inversions. In the angular-velocity diagrams the poles have been chosen so as to illustrate the point that the three velocity diagrams are only sheared versions of one another, and that once one has been drawn, and the appropriate angular-velocity diagram obtained from it, a completely general angular-velocity diagram has, in fact, been obtained; in other words, the ratios 23 : 3C, 3C : C1, etc., are constant.

That this is so can readily be shown as follows:

Star Gear.

For the star gear,

$$\frac{C1}{3C} = \frac{\tan\theta_1}{\tan\theta_2},$$

$$= \frac{\frac{PD}{r_1}}{\frac{PD}{r_1 + 2r_2}},$$

$$= 1 + \frac{2r_2}{r_1}.$$

* Beyer, *Maschinenbau*, 1927, page 1080.
† Kutzbach, *Maschinenbau*, 1929, page 718.

VELOCITY RATIOS OF EPICYCLIC GEARS.

Fig. 5.

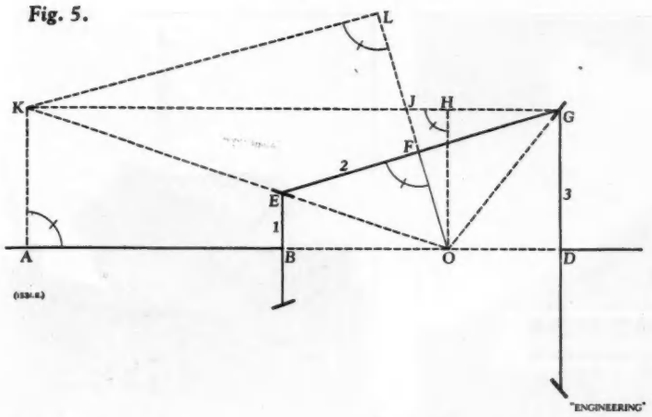
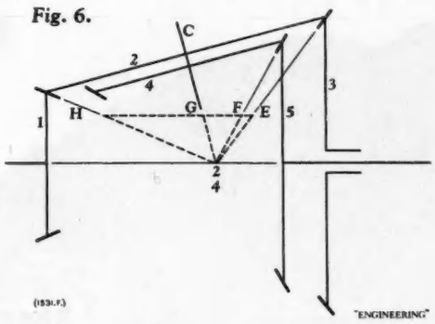


Fig. 6.



Planetary Gear.

For the planetary gear,

$$\frac{C1}{3C} = \frac{\tan(\theta_2 + \theta_4) - \tan\theta_4}{\tan\theta_4},$$

$$= \frac{\frac{PD}{r_1}}{\frac{PD}{2}} - 1$$

$$\frac{r_1 + r_2}{}$$

$$= \frac{2(r_1 + r_2)}{r_1} - 1$$

$$= 1 + \frac{2r_2}{r_1}$$

Solar Gear.

For the solar gear,

$$\frac{C1}{3C} = \frac{\tan\theta_5}{\tan(\theta_5 + \theta_6) - \tan\theta_5}$$

$$= \frac{1}{\frac{MN}{r_1 + 2r_2}\ \frac{2(r_1 + r_2)}{MN} - 1}$$

$$= 1 + \frac{2r_2}{r_1}.$$

Above each of the angular-velocity diagrams have been drawn the appropriate vectors indicating the magnitude and direction of the rotations in which we are interested in order to obtain the gear ratios. The gear designer is also interested in the angular velocity of the planet relative to the cage, since this gives the planet bearing speed. This is given in each diagram by the line 2 C.

A further important quantity is the relative pitch-line velocity of the gears, since on it depends not only the relative velocity of sliding of the teeth (and hence the tooth-engagement losses) but also the magnitude of the dynamic component of tooth load. Considering the velocity diagram for the case when the annulus is fixed, the absolute pitch-line velocity of the sun is given by PD. The cage is rotating in the same direction, and at the radius of the pitch line of the sun the point of contact is moving with an absolute velocity PX, since it is at rest relatively to the cage. The relative pitch-line velocity is therefore (PD − PX), and since this is smaller than PD the relative pitch-line velocity is lower than it would be for a similar star or parallel-shaft gear. The diagram has been extended by the dotted lines to show that YZ, the pitch-line velocity at the annulus, is identical with DX, the relative pitch-line velocity at the sun-planet contact.

COMPOUND EPICYCLIC GEARS.

Fig. 3 shows a compound-planet double-annulus gear which is commonly used to give reductions of up to 1,600 : 1. Clearly such a ratio could not be determined accurately by graphical construction, but a sketch, together with simple computation using the geometry of the figure, will enable the ratio and relative pitch-line velocities of the gear to be determined rapidly. To save work the angular-velocity diagram has been superimposed on the velocity diagram by the addition of the dotted lines. The gear ratio is evidently $+\frac{EH}{EF}$.

Noting that triangles LJK and LEH are similar, and writing r for pitch-circle radii, and ω for the angular velocities, we have

$$\frac{EH}{EL} = \frac{JK}{JL},$$

therefore

$$\frac{\omega_1 r_1}{2r_2} = \frac{\omega_5 r_5}{r_3 - r_1 - r_2 - r_4}.$$

therefore

$$\frac{\omega_1}{\omega_5} = \frac{2r_2 r_5}{r_1(r_2 - r_4)}.$$

This can also be turned into the more usual expression

$$\frac{\omega_1}{\omega_5} = \frac{r_1 + r_3}{r_1}\ \frac{r_2 r_5}{r_2 r_5 - r_3 r_4}.$$

The method can be used for trains of any degree of complexity; it will sometimes be found easier to start drawing the velocity diagram from an arbitrary point in the train rather than from the input shaft.

BEVEL GEARS.

In Fig. 4, a bevel epicyclic train is analysed, for the case where wheel 3 is fixed, exactly as though it were an ordinary epicyclic train, and it will be proved that, as before, XZ and YZ represent, respectively, the angular velocities of wheel 1 and the cage about the axis of the gear. In addition, a line 1 C 3 has been drawn parallel to the axis of 1 and 3, intersecting the axis of 2 and the generators of the bevels, and it will be shown that not only do 1 3 and C 3 represent the angular velocities of wheel 1 and the cage, but that CO represents the angular velocity of wheel 2 about its own axis. This gives a remarkably simple construction for obtaining both the relative magnitudes and directions of angular rotation of all the components of the gear.

The proof of this can be obtained from Fig. 5, where KG is now the line parallel to the axis of 1 and 3. OH is perpendicular to KG and KL is perpendicular to OL. Consider the motions of the gears when OF is fixed in space:

$$\omega_1 \cdot EB = \omega_3 \cdot GD$$

therefore

$$\frac{\omega_1}{\omega_3} = \frac{GD}{EB} = \frac{AK}{EB} = \frac{OK}{OE} = \frac{LK}{EF} = \frac{LK}{FG} = \frac{JK}{JG}.$$

Also

$$\frac{\omega_2}{\omega_3} = \frac{GD}{FG} = \frac{HO}{FG} = \frac{JO}{JG}.$$

Therefore, JK, JG and JO are vectors representing the angular velocities in magnitude and, as can be seen by inspection, in direction. In Fig. 4, the equivalent vectors are 1 C, C 3, and CO. It will also be seen that, since EF = FG and XN = QN, and since 13 is parallel to XZ, by proportion,

$$\frac{C1}{C3} = \frac{YX}{YZ}.$$

For information about the angular velocity of wheel 2, the diagram 1 C 3 O must be used if errors are not to be made with regard to direction and magnitude. Thus, by vector addition, 3 O gives the absolute angular velocity of wheel 2, both in direction and magnitude, but its angular velocity relatively to the cage, which is of interest for bearing-design purposes, is given by CO.

This extremely simple method of analysing bevel-epicyclic trains can be extended to the analysis of compound trains in precisely the same manner as the analysis of simple epicyclic trains is extended to deal with compound trains, and an example of this is shown in Fig. 6. The numbering of the wheels and the lettering of the angular-velocity diagram have been made the same as in Fig. 3 in order to bring out the equivalence of the two forms of gear.

The simplicity and power of the methods outlined in this article make them the best analytical tool for studying the directions of rotation and the pitch-line velocities in epicyclic gears, since a sketch will present the whole story qualitatively and a few lines of simple geometry will suffice for any calculation, should graphical accuracy be inadequate. In the case of very simple epicyclic trains, the usual tabular method of computation may be more rapid if only gear ratios are required, but anyone other than the experienced epicyclic-gear designer can profitably check his results with the aid of a simple sketch.

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"SINGLE-DECK HIGH-SPEED CAR FOR LEEDS TRAMWAYS": CORRIGENDUM.—It has been pointed out to us by Messrs. Crompton Parkinson, Limited, Chelmsford, that, in our article on page 124, *ante*, under the above title, it is stated that the Leeds Corporation have decided to adopt this new type of car as standard; whereas it is an experimental car, which is being tested to decide whether it should be adopted as the standard type for future development. We regret any misunderstanding that may have been caused by the wording of our article.

ERECTING A 500-TON FLOATING DOCK ON LAKE NYASA.

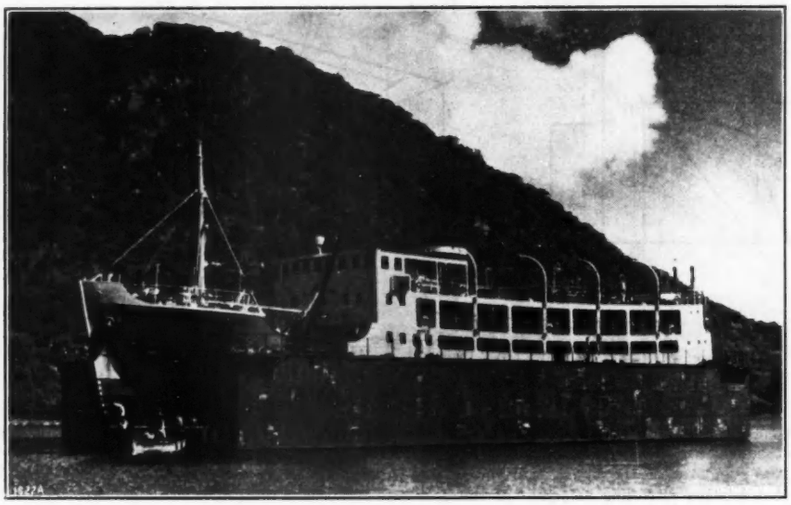


FIG. 1. M.V. "ILALA" IN FLOATING DOCK.

FIG. 2. BOWS OF VESSEL AND DOCK.

ERECTING A 500-TON FLOATING DOCK ON LAKE NYASA.

AN unusual erecting job was completed on Lake Nyasa, Central Africa, a few months ago. A floating dock with a lifting capacity of 500 tons, designed for use on this fresh-water lake, was constructed in England, shipped out in parts to Africa, and finally assembled and riveted on the shore of the lake and on the lake itself, employing African labour. The dock has been provided for the maintenance of the Nyasaland Railways' lake fleet, the largest of which, the m.v. Ilala (420 tons light displacement), had previously been erected by the same staff. The fleet also includes the 'Mpasa, of 250 tons, seven tugs and some minor vessels. The railways' new maintenance base is in sheltered Monkey Bay, and a floating dock was necessary as the lake is subject to a 20-year cyclic rise and fall of 18 ft. Figs. 1 and 2 show the Ilala docked for the first time.

The floating dock consists of four pontoons, each 5 ft. 10 in. deep, 51 ft. 3 in. wide and 33 ft. 4 in. long, arranged in line with a gap of 4 ft. 2 in. between adjacent pairs. The overall length of the pontoons is thus 145 ft. 10 in. The two side walls of the dock, bolted along the top edges of the pontoons, are vertical plated caissons 15 ft. 10 in. high and 5 ft. 5 in. wide, with three watertight bulkheads in each. With a platform cantilevered out 7 ft. 6 in. at each end of the pontoons, the overall length of the dock is 160 ft. 10 in., and with fenders on the inner faces of the side walls there is a clear entrance width of 36 ft. The machinery of the dock comprises a 10-kW Diesel generator set, a 7-brake horse-power motor, control gear, 7-in. centrifugal pump, pipes, valves, valve-lifting gear, etc. The engine house is on the starboard wall. The gross weight of the dock is 411 tons; with 175 tons of water remaining in the pontoons, the gross weight is 586 tons.

The first consignment of material arrived in Nyasaland at the end of 1950 (the design of the dock was fully described, with drawings, in ENGINEERING, vol. 169, page 257 (1950)). As, however, all the railway staff skilled in this kind of work were fully engaged on the erection of m.v. Ilala, and on other works, it was not possible to start on the dock until April, 1951. Most of the erecting work was carried out on the shore of the lake, as shown in Fig. 3. The pontoons, one of which is shown practically ready for launching in the illustration, presented no special difficulties. As much as possible of the internal riveting was done before the top plates were put on; the temperatures at Monkey Bay (as high as 97 deg. F. in the shade) made conditions very trying for those who had to work inside, especially after the top plates had been fitted. The piping was installed in the pontoons before the top plating, but the joints were not finally made in case the pontoons should deform slightly after launching. Before painting, the pontoons were tested by means of a water hose on the outside surfaces and the internal bulkheads. The first pontoon was launched in November, 1951, the second in January, 1952, the third in May, 1952, and the fourth in July, 1952.

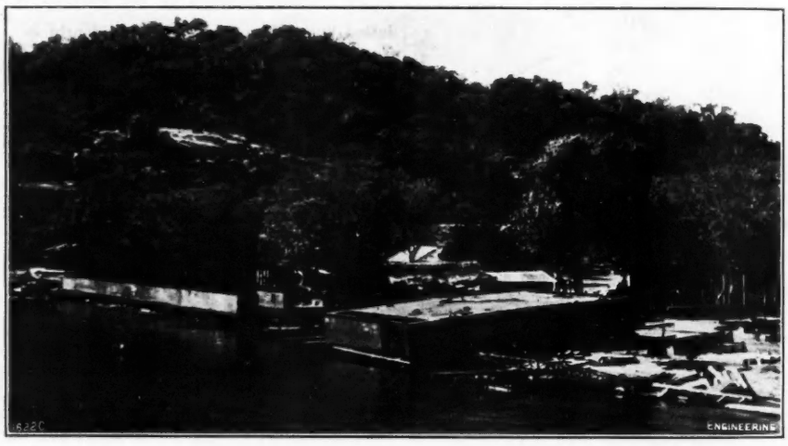


FIG. 3. PONTOON AND SIDE WALLS UNDER CONSTRUCTION.

Meanwhile, in March, 1952, a start had been made on the erection of the side walls. It was decided to erect them only partly on shore, and then to skid them sideways on to the floating pontoons. The floor plating, all the vertical frames and the bottom strake of side plating were erected and riveted before moving the side walls into place. The walls at this stage are visible on the left of Fig. 3. As they would have been difficult to move longitudinally, great care was taken to ensure that they were erected in their correct relative positions. The four pontoons were then moved off-shore opposite the side walls and ballasted with water to bring their decks to the correct level to receive the walls. Two skid rails were laid on the deck of each pontoon, continuing out under the walls, and the walls were then moved by means of jacks. The relative longitudinal positions of the walls were carefully maintained during jacking. When the walls were approximately in their correct positions, at the right distance apart, each pontoon in turn was flooded sufficiently to withdraw the skids, and then pumped out until it came into contact with the bottom of the walls, when it was finally adjusted to its correct position and service bolted. This operation was carried out in July, 1952.

The remaining erection and riveting of the side walls were then completed. Holes for the bolts connecting the walls to the pontoons were reamed out and watertight joints made with three layers of canvas steeped in red lead. The machinery and piping were then installed and all pipe joints made. The pontoons were given two coats of bituminous solution and one of bituminous enamel on the outside, and one coat of non-drying grease paint on the inside. The side walls were painted externally with two coats of red lead and one of oil paint.

Except for some minor painting, the dock was completed on March 23 this year. It was tested by sinking it to its full depth and pumping out. On March 31 the m.v. Ilala was docked for hull inspection. The dock was lowered in 90 minutes, and at the end of this time there were 7 ft. of water over the keel blocks at the bow end of the dock and 8 ft. at the stern. The ship was then warped into the dock, using two lines at the bow of the ship and a tug at the stern to keep her straight. Though there was a fair breeze blowing at the time, the operation presented little difficulty. The ship, drawing 4 ft. 10 in. forward and 6 ft. 9 in. at the stern, was brought into the dock in 40 minutes. At 9.47 a.m. pumping was commenced, and at 10.30 a.m. the keel blocks first came in contact with

ACOUSTIC WALL AT LONDON AIRPORT.

Fig. 1.

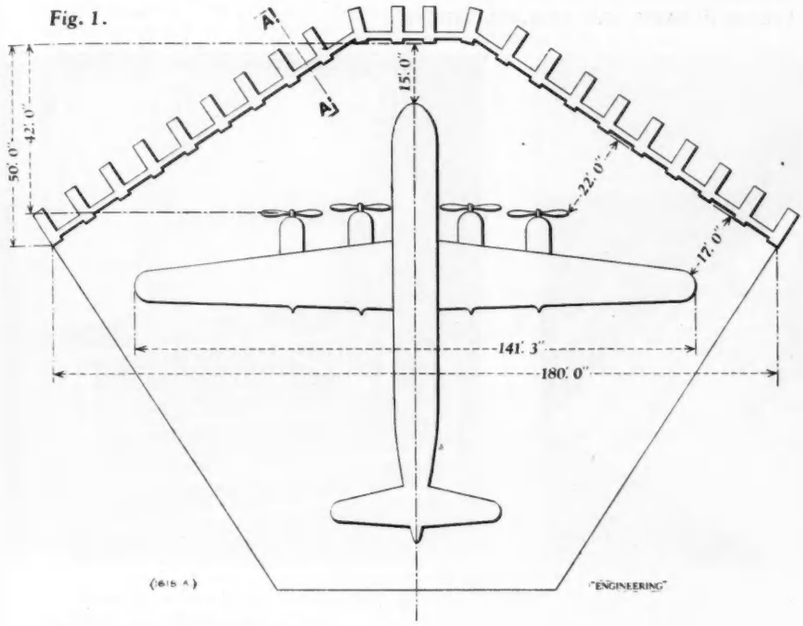


Fig. 2. SECTION A-A (FIG. 1).

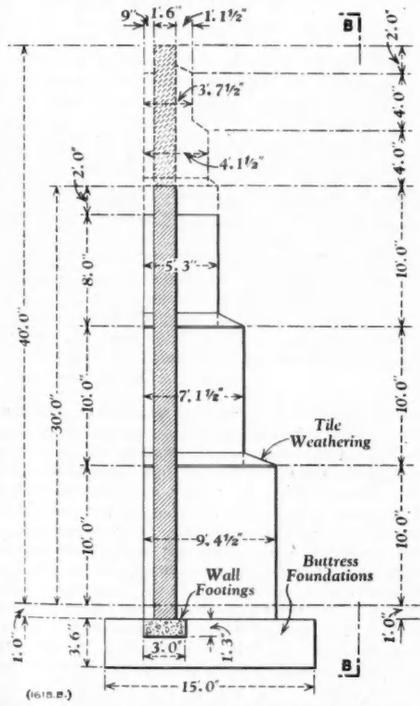
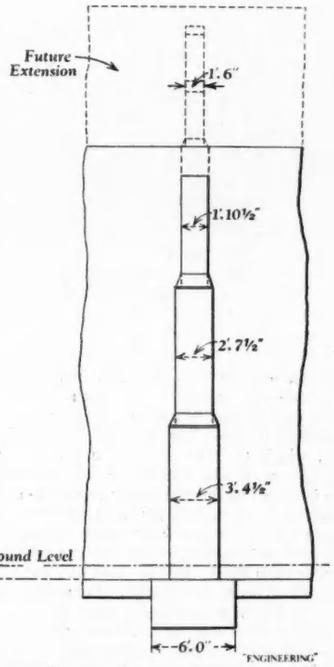


Fig. 3.
ELEVATION B-B (FIG. 2).



the vessel at the stern. When contact had been made over the whole length the bilge blocks were hauled into place and the side shores tightened. At 1.15 p.m. the pontoon decks were 9 in. above the water level and pumping was stopped. The dock and ship in this condition are shown in Figs. 1 and 2. Fifteen days later the dock was lowered. The valves were opened at 1.45 p.m., the vessel was afloat at 3.12 p.m. and it was clear of the dock at 3.38 p.m. Subsequently, the dock was raised in two hours.

The dock was built for Nyasaland Railways, Limited, by Head, Wrightson and Company, Limited, Teesdale Iron Works, Thornaby-on-Tees. It was designed by the late Dr. E. H. Salmon, M.I.C.E., of Messrs. Clark and Standfield; and the consulting engineers to the Nyasaland Railways were Messrs. Livesey and Henderson, National House, 12-18, Moorgate, London, E.C.2.

AERONAUTICAL RESEARCH SCHOLARSHIPS.—The English Electric Co., Ltd., Queen's House, Kingsway, London, W.C.2, have recently established a research studentship in aeronautics, valued at 500*l.* a year, at the Imperial College of Science and Technology, in addition to the two fellowships at the University of Glasgow and the College of Aeronautics, Cranfield. The latter fellowship has been awarded this year to Mr. R. G. Anderson, 6, St. Andrew's-avenue, Ashton, Preston, a member of the mathematical section of the aircraft division of the English Electric Co., Ltd. The Perring Scholarship at the College of Aeronautics, Cranfield, has been awarded to Mr. A. Coull, Lonmuir, Ugie-street, Peterhead.

ACOUSTIC WALL FOR AERO-ENGINE TESTS.

DURING the past two years, the Ministry of Civil Aviation have been carrying out tests at London Airport with an acoustic screen wall in an attempt to provide data on the problem of reducing the noise nuisance to local residents from running-up aircraft engines after maintenance work in the adjacent hangar area. The tests showed successfully that a considerable reduction in loudness level could be obtained by the use of a screen wall—much greater, in fact, than had been expected.

As a result of these experiments, therefore, the Ministry decided to build a permanent brick acoustic wall, the construction of which has recently been completed; proving tests on the wall have commenced. Figs. 1, 2 and 3 show the layout, dimensions and constructional features of the 30-ft. high wall, which is designed to accommodate the largest air-liner at present in use at London Airport, the Boeing Stratocruiser, with a wing span of 141 ft. 3 in. The design of the wall makes provision for an extension to a height of 40 ft. should it prove to be desirable. The shallow flattened V plan-form provides the maximum screening effect in combination with economy of materials. The thickness of the brickwork was decided on structural considerations, and is more than adequate for providing the necessary acoustic absorption. It will be apparent from Fig. 1 that there is no screening effect in the direction of the open sides of the V, and therefore the site and orientation of such a wall have to be carefully selected to provide the desired protection to built-up areas.

The preliminary experiments which led to the construction of the wall have been fully described in the January issue of the *Journal of the Royal Aeronautical Society*,* but it may be of interest to give an outline of the tests.

The investigation was planned to explore the "acoustic shadow" cast by an obstacle in front of the noise source. It was thought at the time that the effectiveness of the obstacle in reducing noise transmission might not extend beyond a short distance in front of the obstacle, on account of diffraction around the sides and scattering. In fact, this was not found to be so, and at distances up to 2,500 ft. from the source of noise a fairly uniform reduction of loudness level was obtained. The starboard engine (Bristol Hercules 630) of a Viking 1A aircraft provided the source of noise, and sound measurements, in decibels over eight octaves, were made at various distances from the source with an objective noise-level meter manufactured by Standard Telephones and Cables, Limited. The eight sound-pressure levels at each station were then converted to give a single loudness level in phons.

The obstacle, which was erected in stages with the idea of determining the most effective dimensions, consisted of tubular steel scaffolding erected in the form of three sides of a rectangle and covered progressively with corrugated asbestos-cement sheeting ¼ in. thick. To provide a wing-tip clearance of 10 ft., the span of the wall was made 110 ft. and the side walls were 30 ft. deep. Although the test points were too widely scattered to enable the loudness-level reduction to be correlated with the wall height, it was found that as the height of the wall was raised to the maximum, 40 ft., the reduction of loudness level increased to about 25 phons throughout a range of distance from the wall of 100 ft. to 2,500 ft., and the screening was effective over almost the whole of the shadow area. The most effective screening was obtained when the engine was located as close as possible to the wall. A Comet aircraft with Ghost jet engines was also tested behind the wall, and similar reductions in loudness level were obtained. Tests were also carried out, at Blackbushe airport, on the screening effect of closely-planted 15-ft. trees, but they were found to be much less effective.

* "Acoustic Screening by an Experimental Running-up Pen," by J. D. Hayhurst, *J.R.Ae.S.*, January, 1953, pages 3-11.

PERSPECTIVE DRAUGHTING MACHINE.

FRANZ KUHLMANN, K.G., WILHELMSHAVEN.

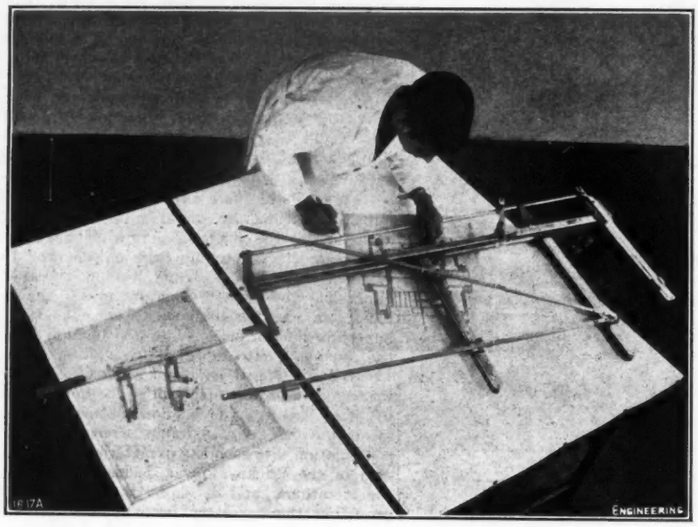


FIG. 1. MACHINE IN USE.

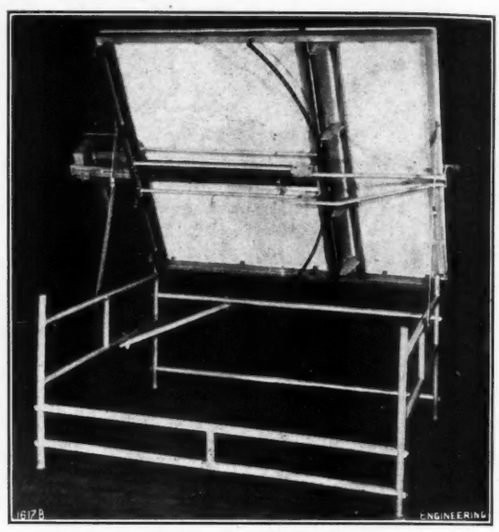


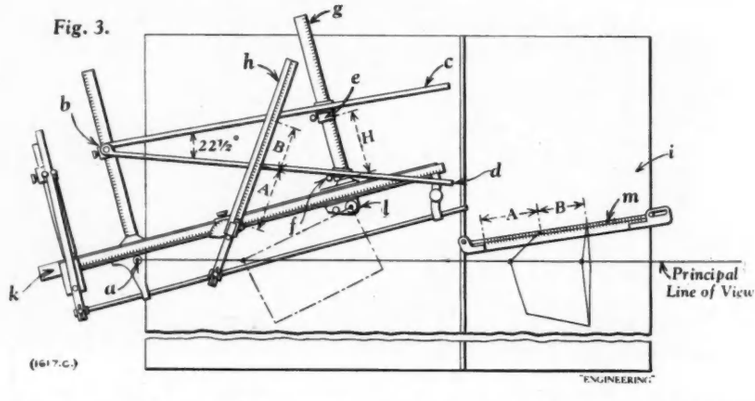
FIG. 2. UNDERSIDE OF MACHINE, SHOWING PART OF MECHANISM.

PERSPECTIVE DRAUGHTING MACHINE.

THE perspective draughting machine shown in the accompanying illustrations is made by Franz Kuhlmann, K.G., Wilhelmshaven, Germany, and was exhibited by them at the Factory Equipment Exhibition held earlier this year in London. It has been designed to enable any person without previous experience of three-dimensional drawing to produce a true perspective drawing from a plan and elevation. If the heights of the object to be drawn are known, an elevation is not required. The size, angle of view, eye level, and the distance from the observer may all be chosen at will and the machine can be set to produce the correct dimensions in their appropriate positions once the choice has been made. Perspective representation is a common practice among architects, but it is rarely adopted in engineering because of the time and expense involved and the additional detail which makes three-dimensional representation of a machine or other mechanical object extremely difficult. This machine, it is claimed, overcomes these difficulties. Fig. 1 shows the machine in use.

It is mounted on a steel frame to which two drawing-boards are attached, and the frame is supported on a tubular steel stand. Two corners of the frame are held to the stand by hinges so that the frame and boards can be raised to an angle of 80 deg. from the horizontal and locked in position when setting the scales beneath the board prior to operation, as shown in Fig. 2. The machine itself consists of a number of finely machined steel arms with accurately marked scales on each of them. The gear underneath the table provides a link with the Perspex scale *m* shown in Fig. 3, on the smaller board, *i*, on which the pictorial drawing is produced, and the arms of the gear beneath the table are suspended at the ends on rails and ball-bearings which act as carriage wheels. The scale on the smaller board is removable and a lens with sighting lines is attached to the main arm of the machine for sighting the points to be drawn or plotted. The whole gear moves about a main pivot *a* at the side of the board furthest from the view being drawn. This pivot comprises a rigid main casting with a pivoting shaft running in ball bearings and to it are linked all the control arms of the machine. The two boards together measure 57 in. by 63 in.; the smaller board is 57 in. by 23 in. The inclination of the picture plane is up to 45 deg. above or below the horizontal. The angle of view in the horizontal plane is up to 60 deg.

Fig. 3.



To set up the machine it is first necessary to determine the point from which the object is to be viewed and mark on the plan the vertical projection of the observer. The principal line of view, which may be likened to the line of view of a camera, is also marked on the drawing. The plan is then fixed to the larger of the two drawing-boards in such a position that the vertical projection of the observer coincides with the main axis *a* of the machine and that the principal line of view runs perpendicular from the axis *a* to the adjacent edges of the boards. It is suggested that all the outlines of the object should be drawn within an angle of 55 deg. symmetrically disposed with regard to the principal line of view and having for the vertex the centre of the axis *a*; this angle corresponds approximately to the clear field of vision of a fixed human eye. If this angle is exceeded in the plan or elevation, the representations obtained will still conform to the laws of perspective, but distortions of a kind to which the human eye is unaccustomed are introduced.

Having fixed the plan, the desired height of the point of observation above the horizontal plane is set on the scale of the side-arm at *b* by adjusting the slide and thumbscrew to which the ends of the arms *c* and *d* are attached; this height can be chosen to give a bird's eye view, or an eye-level view. Alternatively, a view from a point below the base line may be selected. This height-scale, with its arms *c* and *d*, which represent the lines of view of the observer, have in effect been turned out of the vertical plane and placed in the same plane as the board. The final adjustment that must be made is to the distance of the object or drawing from the point of observation. This adjustment determines the size of final perspective picture. The resulting view may be compared with that obtained in the sighting lens of a camera, in which the desired picture appears in perspective. By loosening the thumbscrew on the slide *e* or *f* and moving one of the two arms *c* or *d*, the bisector of the angle of view corresponding to the principal line of view is then selected and this is represented in the vertical plane on the scale *g*. Next, the Perspex ruler *h* is set in position, by loosening its two clamping screws, so that its centre line lies on a line at right-angles and perpendicular to the aforementioned selected arm *c* or *d*, according to which was used as the bisector of the angle of view, and at the desired distance from the point of observation *b*. If the vertical lines in the perspective drawing are required to remain parallel, these adjustments must be made with the Perspex ruler *h*, in a position perpendicular to the guide-rail *k*. Any deviation of the Perspex ruler from this position causes a convergence of the naturally parallel lines towards a vanishing point which will be above or below the ground plane according to the rules of perspective, if an inclined picture plane has been chosen. When these three adjustments have been made, three values are read from the machine and the final adjustments and corrections based on these readings are made. This being done, the perspective draughting machine is ready for use. The method of making a perspective drawing

can best be explained by considering a rectangular block as shown in Fig. 3. First, the plan of the block is placed in position as described above and the instrument adjusted. The centre of the sighting lens, which is mounted on the carriage *l*, is then set to a corner of the block, by swinging the guide-rail *k* around and sliding the carriage and the arm *g* along it. The ruler *m* on the small drawing board automatically moves into the correct position and angle corresponding to the vertical edge of the block. The height of the block H is set on the arm of the carriage *g* by means of the slides *e* and *f*, according to the scale chosen. The arms *c* and *d* which are guided by the slides *e* and *f*, pivot about the point of observation *b* in the vertical plane to give two readings, A and B, at the centre line of the Perspex ruler *g*. These readings are then transferred by the operator to the small drawing board and marked off against the graduated scale *m* and a straight line is drawn between them which represents the height of the block when viewed in perspective. The same procedure is repeated to produce the three other edges. The pictorial representation is completed by connecting the relevant end points together. For this purpose, the Perspex scale on the second drawing board can be removed.

For representing larger objects, such as buildings, steel structures, or parts of machines, a similar procedure is followed, the vertical edges of the object being drawn in first. Non-vertical straight lines and curves, etc., can also be transferred into the perspective drawing by transferring the appropriate points and connecting up, or by plotting. Thus, any definitely specified point on the plan can be transferred. In such cases, the height of the point from the ground plane is set on the arm *g* by means of the single slide *f* and is read on the corresponding ruler at the intersection with the Perspex ruler *h*. It is then transferred to the scale *m*, as described before. Without any auxiliary construction, therefore, and by mere mechanical transfer of edges and points and by connecting them on the drawing board a perspective representation of even the most intricate objects is obtainable according to the selected size, point of view, eye-level, and distance of the picture plane.

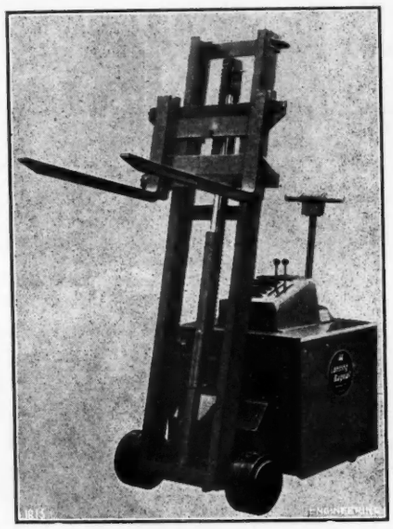
Franz Kuhlmann, K.G., celebrated their fiftieth anniversary on July 1 this year. The present principal of the firm took over, on July 1, 1903, the mechanical workshop which his father, B. F. Kuhlmann, had founded in 1888. From the beginning, the firm specialised in the development and manufacture of precision apparatus, calculating machines and measuring instruments being among their products. They started producing engraving machines in 1908 as a result of their own requirements, and these machines still constitute an important part of their output. It is in the production of draughting machines, however, that they are perhaps best known. The works was considerably damaged during the last war, but it has since been reconstructed. The firm's agents in this country are Messrs. Bruce Starke and Company Limited, Fenchurch House, 5, Fenchurch-street, London, E.C.3.

ITALIAN PRODUCTION OF BALL BEARINGS.—Early this month, the Italian Government made an urgent request to the Raw Materials Committee of the Organisation for European Economic Co-operation for permission to export ball bearings to Poland and Czechoslovakia, from which countries tentative orders for bearings, valued at 30,000,000*l*, have been received. Italian steelworks generally appear to be facing a crisis caused by serious over-production.

THE INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING.—When the Executive and Permanent Committees of the International Association for Bridge and Structural Engineering held their 20th and 19th meetings, respectively, in Zürich, between June 22 and 25, under the presidency of Professor F. Stüssi, an invitation was received from Professor Dr. E. Torroja, of Madrid, to hold the next meetings of the two committees there in September, 1954; and Professor J. Belard da Fonseca, who was elected a vice-president, invited them to hold the next Congress of the Association in Lisbon in 1956.

FORK-LIFT TRUCK.

THE fork-lift truck shown in the accompanying illustration is battery powered and is model PF.100 made by Lansing Bagnall, Limited, Kingsclere-road, Basingstoke, Hampshire. The truck, with an unloaded weight of 2,030 lb., has been designed for use on galleries and in lifts where extra weight is prohibitive; the load capacity is 1,000 lb. when the effective weight acts 15 in. in front of the heel of the fork, and the full lift of 67 in. can be achieved in about 15 to 20 seconds. The overall dimensions have been kept low in order to obtain manœuvrability and to allow the truck to be used in narrow aisles of storerooms and workshops; the principal dimensions are: wheelbase, 30 in.; length measured from the heel of the fork, 47 in.; and overall width, 32 in., which allows the truck to operate in passages only 48 in. wide. The sensitivity of control required for operation in such confined spaces is ensured by low maximum speed, 4 m.p.h., and by the fact that the truck is pedestrian-controlled.



The driving controls are all located in the head of the handle and comprise a twist-grip speed control and a pre-selective reversing switch; as shown in the illustration, the lifting and tilting controls, as well as the ignition switch, are within easy reach of the operator. The whole of the driving unit, comprising the handle with its combined driving and steering wheel, the motor, control box and gearbox, is mounted on a 10-in. diameter track bolted to the main frame; the whole driving unit therefore follows the control handle, but a full drive is maintained throughout a rotation of 200 deg. Under the action of a spring, the handle automatically returns to the vertical and, in so doing, applies the brake; the twist grip also returns to the "off" position as the handle is released. On down-grades, the regenerative braking system limits the speed of the truck, simultaneously recharging the batteries and reducing wear on the cone-type mechanical brake mounted directly on the driving shaft.

The electrical drive of the truck provides a smooth and silent movement, and has the advantage of avoiding the emission of exhaust fumes, which are inevitable with petrol or Diesel engines. Once products have been arranged in unit loads and palletised, it is obviously desirable to eliminate man-handling wherever possible; this new fork-lift truck has been designed to permit mechanical handling to be exploited in more restricted spaces than has been practicable in the past.

ANNUAL DINNER OF THE BRITISH ELECTRICAL AND ALLIED MANUFACTURERS ASSOCIATION.—The date of the annual dinner of the British Electrical and Allied Manufacturers Association has been changed from Wednesday, November 18, to Monday, November 16, 1953. It will be held at Grosvenor House, London, W.1.

100-IN. GEAR-HOBBING MACHINE.

THE first of a new series of hobbing machines for cutting turbine gears has been completed recently by David Brown Machine Tools, Limited, at their Britannia Works, Sherborne-street, Manchester, 3, and is now in production in a temperature-controlled shop at the works of their parent company, David Brown and Sons (Huddersfield), Limited. It is capable of cutting gears on wheels from 28 in. up to 100 in. in diameter, with a normal pitch of 2 D.P., and has been constructed in accordance with British Standard Specification No. 1498-1948. Illustrations of the machine, which is listed as the MH 100, are given in Figs. 1 and 2, on page 204, and Figs. 3 and 4, on page 205. The range of machines to which it belongs will consist eventually of three sizes, the other two, MH 150 and MH 200, having capacities of 150 in. and 200 in. maximum gear diameter, as the reference numbers indicate. The specification mentioned covers two grades of machine, A and B, the latter requiring a high quality of production from gears running under normal loading and pitch-line velocities; whereas Grade A, to which the MH type of machine conforms, relates to machines designed to produce gears that have a relatively high loading in conjunction with a high pitch-line velocity.

As can be seen in Fig. 1, the machine comprises an upright carrying the hobbing head and mounted on a heavy bedplate, the front portion of which provides a seating for the table; the rear section has on its upper surface horizontal guides of liberal proportions on which the upright can be traversed to and from the work. The bed is in halves, its two iron castings being bolted together and located with dowels and tenons. The upright is of box section and contains the hob-slide balance weight; it can be moved along the bed either by power or by hand. The maximum vertical traverse of the hob slide (an enlarged view of which appears in Fig. 2) is 70 in. and the centre distance, from the hob to the table, is 68 in. maximum and 16 in. minimum. The diameter of the work table is 108 in. The hob has a length of 12 in. and a maximum diameter of 10 in. and is carried on a spindle which, at the driving end, is $4\frac{1}{2}$ in. in diameter; its speed can be adjusted from 20 to 100 revolutions per minute. The diameter of the work-table bore is $14\frac{3}{4}$ in. The vertical traverse is from 0·007 in. to 0·070 in., and the power in-feed, 0·0125 in. per revolution of the table. The overall dimensions of the machine are 21 ft. 3 in. in length, 11 ft. 9 in. in width and 14 ft. 6 in. in height, and its weight is approximately 50 tons.

The hob slide is located on the upright by long narrow guides, to ensure precision of movement. The vertical traverse is effected by a screw of large diameter, to be seen above the slide in Fig. 2; it was produced on the makers' master screw-cutting lathe, and its accuracy has been certified by the National Physical Laboratory to be well within the limits given in the British Standard Specification. The feed-screw nut assembly comprises two nuts, one being fixed and the other adjustable. The hob slide is mounted on a seating of large diameter which can be swivelled through 180 deg. about its horizontal centre line, to enable either right-hand or left-hand teeth to be cut. This motion is operated by hand on the MH 100 and MH 150 machines, but by power on the MH 200. The hob spindle is located in the final driving gear by multiple splines, and has a conical bearing at the nose end, with provision for axial adjustment to correct any excessive clearance in the gears being cut. This adjustment is effected by rotating a pinion which meshes with a rack in the bracket carrying the bearing.

The table is located axially in the bed by flat annular seatings and radially by a spigot bearing of comparatively small dimensions, but machined with great accuracy. Part of the load on the table can be compensated by hydraulic pressure so thar a constant bearing pressure can be maintaihed, irrespective of the weight of the gearwheel that is being cut. Two dividing wormwheels are provided one of coarse pitch for roughing and the other a

HOBBING MACHINE FOR TURBINE GEARS.

DAVID BROWN MACHINE TOOLS, LTD., MANCHESTER.

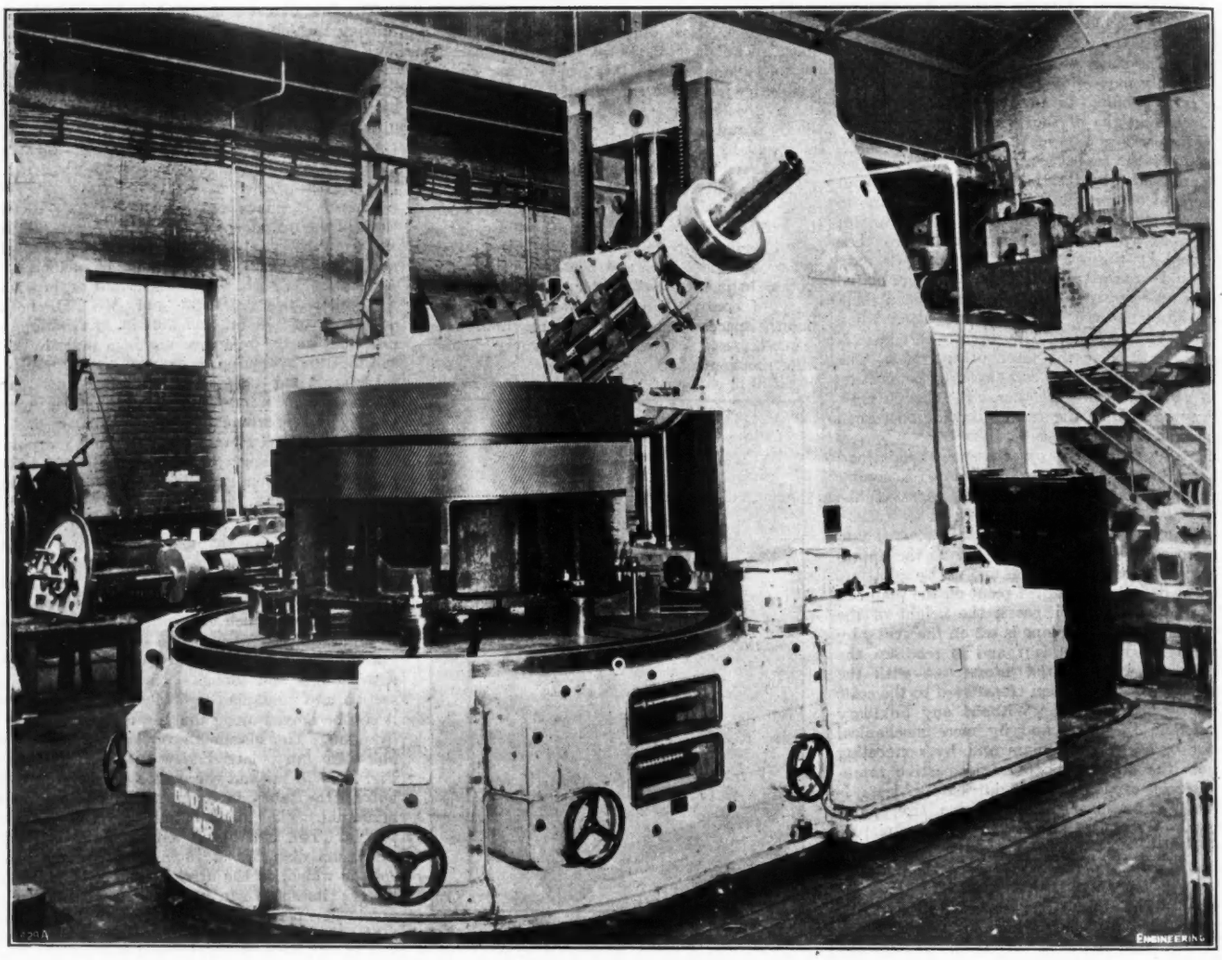


Fig. 1. The MH 100 Gear-Hobbing Machine.

fine-pitch master wheel for finish-cutting. The coarse-pitch wheel is used also in setting up the work, for which purpose it can be coupled to an independent motor, to rotate the table quickly. Fig. 3, on page 205, shows the two worms. Both are easily engaged. Electric interlocks prevent the independent table motor from being started while the fine-pitch wormwheel is engaged, so that it is impossible to attempt to drive both worms at once. The master wormwheel has 800 teeth, thus giving the maximum continuous engagement with the worm and ensuring an exceptional accuracy of division and of surface finish in the gears that are cut. It is split at right angles to the axis and through the centre of the teeth, one half being rotated relatively to the other half between semi-finishing cuts so that, the maximum accuracy of pitch can be attained.

The gearbox, illustrated with the doors open in Fig. 4, opposite, is placed at the side of the machine to avoid the need for long driving shafts; its position can be seen in Fig. 1. This box contains the change gears for the feeding, spiralling, indexing and prime mechanisms, and is force-lubricated; the hob speed-change gears are in a separate compartment, at the other side of the machine, and run in an oil bath. Profile-ground spur gears, supported in ball bearings, are used in the differential for the spiralling and prime mechanisms, to minimise the risk of errors. The gears and bearings in the hob slide, saddle, and the top box of the upright receive a circulated supply of oil, but forced lubrication is provided for the table unit, and, as stated above, for the main gearbox. For this purpose, there are

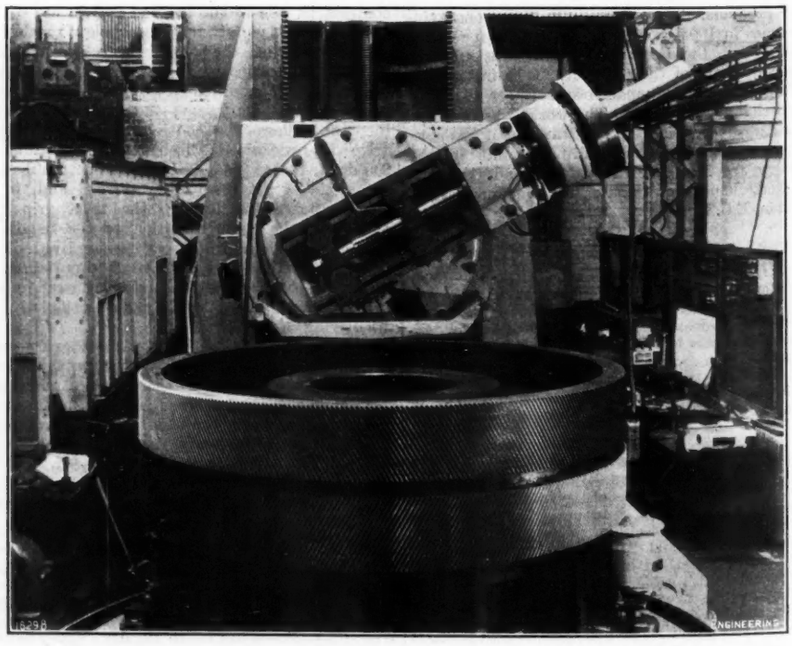


Fig. 2. Hob Slide.

GEAR-HOBBING MACHINE.

DAVID BROWN MACHINE TOOLS, LTD., MANCHESTER.

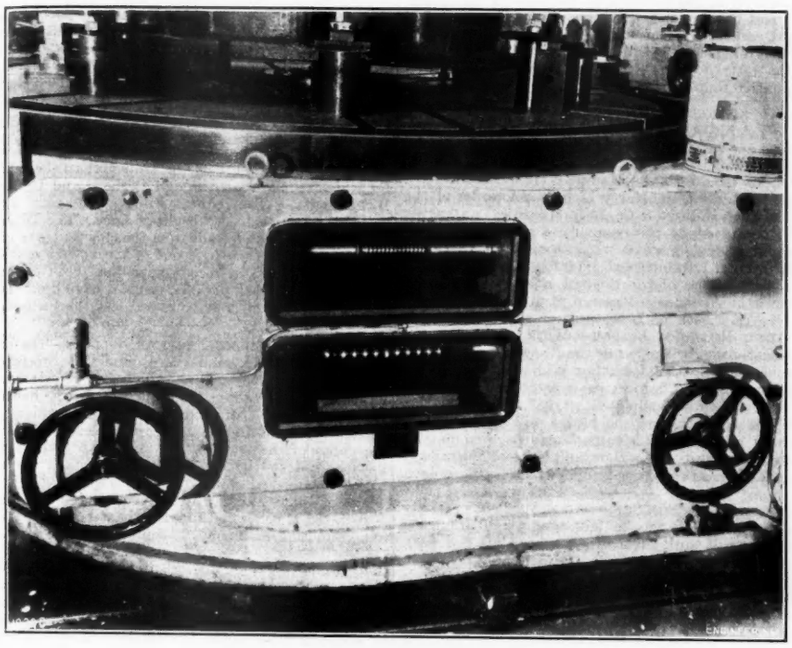


FIG. 3. WORM GEARS IN TABLE DRIVE.

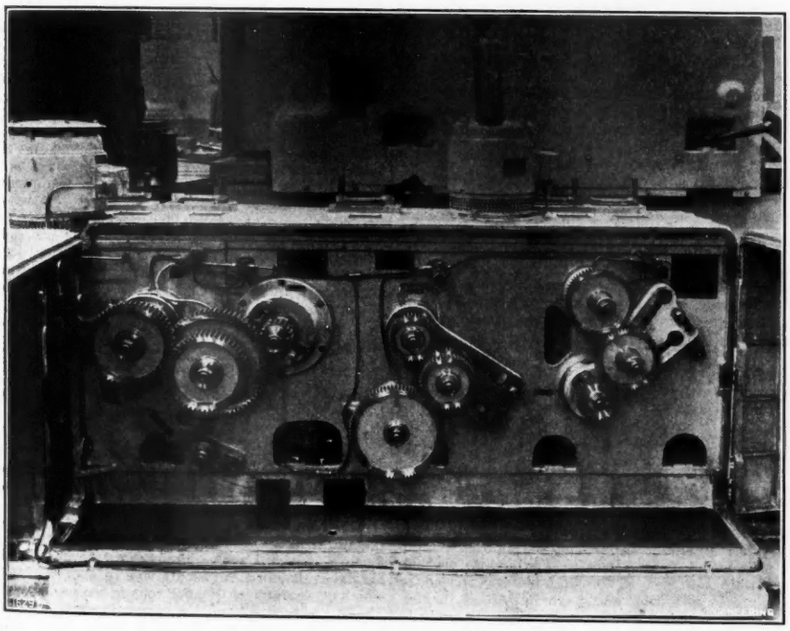


FIG. 4. INDEXING, SPIRALLING AND FEED-CHANGE GEARS.

two gear pumps, mounted in tandem and driven by a 1-h.p. motor. One pump supplies oil to relieve the load on the table and the other lubricates the two sets of dividing gears and the main gearbox. A similar pump is provided as a standby, and is brought into use automatically in the event of any failure of the oil flow. Gauze and magnetic strainers are fitted, and either pump can be removed for overhaul without stopping the machine. The cutting oil is contained in a tank of large capacity and is circulated by a motor-driven gear pump. A stand-by coolant-pump is also provided, and is a duplicate of the main unit. The coolant tank is fitted with settling compartments, and filters of fine gauze.

The machine is equipped with eight electric motors for the various drives, all the controls being brought together in a single cabinet. The main motor is a variable-speed unit of 10 to 20 h.p. The hob-slide traverse motor and the rapid-rotation table motor are of 5 h.p. each, the upright traverse motor of 2 h.p., and the lubricant and coolant pump motors, 1 h.p. each. The motors of the MH 150 and MH 200 machines are of similar powers except that the table-rotation motor, in the case of the MH 200, is of 10 h.p. The use of a variable-speed motor for the main drive enables a wide range of hob speeds to be obtained with the minimum number of gear changes. The hob-slide and upright traverse motors operate on alternating current, and only while the respective push-buttons are depressed; limit switches are fitted to prevent over-running. The rapid-rotation motor for the table is also controlled by a push-button, and its connections are so arranged that it cannot be started unless the oil-pump motors are running. Oil-flow switches automatically bring the stand-by pump motors into operation when necessary, and an illuminated indicator shows which pump is in use. The coolant supply system is similarly protected. An ammeter shows the actual horse-power that is being transmitted by the main motor.

The dimensions given above relate, as stated, to the MH 100 machine. The corresponding particulars of the MH 150 and MH 200 machines are as follow, respectively: length, 23 ft. 6 in. and 30 ft. 4 in.; width, 12 ft. 4 in. and 19 ft.; height, 14 ft. 6 in. and 21 ft.; maximum and minimum gear diameters that can be hobbed, 150 in. and 56 in., and 200 in. and 90 in.; maximum vertical traverse of hob slide, 70 in. and 106 in.; maximum and minimum centre distance, hob to table, 83 in. and 30 in., and 115 in. and 48 in.; maximum hob diameter, 10 in. and 12 in.; maximum hob length, 12 in. and 15 in.; diameter of work table, 133 in. and 174 in.; diameter of work-table bore, 30 in. and 42 in.; vertical traverse per revolution of the table, 0·007 in. to 0·070 in. and 0·010 in. to 0·106 in.; range of hob speeds, in revolutions per minute, 14 to 84, and 15 to 60; and power in-feed per revolution of the table, 0·0125 in. and 0·036 in. The MH 150 machine, like the MH 100, cuts to 2 D.P., and the MH 200 to 1½ D.P. The weights of the two larger machines are, respectively, about 74 tons and 113 tons.

LEVELLING BY U-TUBE.

THE "Aqualev" level works on the principle of the U-tube and the law that, geodetically, water always finds its own level. It is being marketed by Messrs. Austin and Trimingham, 58, Warwick-gardens, London, W.14, and consists essentially of two stoppered tubes of glass, and a length of water-filled flexible tube connecting them at their bases; the tubing is normally supplied up to 60 ft. in length, but greater lengths are also obtainable. The apparatus is supplied filled with water and ready for use; to transfer a level from one point to another, the air vents in the screw-stoppers are first opened, when the water level in one tube is then adjusted to the level to be transferred. The water level in the other tube, which may be 60 ft. or more away, will then indicate precisely the same geodetic level. For many operations this instrument can supplant the normal levelling instrument and the method of transferring a level by means of a straight-edge and a spirit-level, while it has the advantage of being able to indicate the levels of points not in the same line of sight, as all that is required in such circumstances is to take the flexible tube round or underneath the obstruction. Its simplicity makes it particularly suitable for the accurate determination of the evenness of floors or the fall in eaves-gutters; numerous other applications, where levels have to be transferred, will be apparent. Another use is in conjunction with a normal levelling instrument, for example, when it is desired to determine the level of a point and the sight-line to it is obstructed; in such a case, the level of the point may be transferred to a staff so placed that it is in view, and a reading then taken.

FLYING-BOAT CHARTER SERVICES.—Aquila Airways Ltd., 1, Great Cumberland-place, London, W.1, have purchased a double-deck 42-seat Short Solent flying boat and two Short Hythe 31-seat flying boats from the Ministry of Supply. The Solent will be flown on the Southampton-Madeira route in early December; the Hythe aircraft will introduce new routes next year.

BRITISH AIRCRAFT EXPORTS.—During June, the British aircraft industry exported equipment worth more than 7*l.* million, exceeding by 1·5*l.* million a record figure set up in May. During the first half of 1953, the industry has exported goods to the value of more than 31*l.* million. Some dozen turbine-driven air liners have already been exported, and export orders are still standing to the value of 26*l.* million, for 22 Comets, 40 Viscounts, and 6 Britannias.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

SCOTTISH SHIPBUILDING.—In the first seven months of this year Scottish shipbuilders launched just under 250,000 tons gross of new shipping, some 17,000 tons less than in the corresponding period of 1952. The Clyde yards were responsible for 200,793 tons, a decrease of 24,450 tons, but the East of Scotland total was 6,800 tons higher, at 48,536 tons. Clyde firms are due to launch about 40,000 tons this month.

STREET LIGHTING IN GREENOCK. Sodium street lighting has just been brought into use over a distance of more than 1½ miles in Greenock. The through roads in the adjoining burghs of Port Glasgow and Gourock have had sodium lighting for some time and the Greenock addition completes a stretch of about eight miles of road lighted in this manner.

DEVELOPMENT OF INDUSTRIES IN THE HIGHLANDS.—A visit by Mr. Peter Thornycroft, President of the Board of Trade, to the Scottish Highlands this week, has raised hopes that some of the minerals in the district may be exploited. Substantial quantities of dolomite exist at Duror, North Argyll, and in the Kishorn area of Wester Ross, to mention only one possibility. The progress of a venture for making bricks from slate rubble, at Ballachulish, is being closely watched by the inhabitants in the numerous old slate-quarrying districts in the West Highlands, where the original industry has been moribund for several years.

THE ENGINEERS' GUILD.—An invitation is extended, during the Edinburgh Festival of Music and Art, by the Scottish Branch of the Engineers' Guild to meet their fellow members who may be visiting the Scottish capital. Members of the Guild who expect to be in Edinburgh between August 23 and September 12, are asked to communicate with Mr. C. M. Beckett, 8, House o' Hill-row, Edinburgh, 4 (Edinburgh 77785), so that details of the arrangements, which will be finally made to suit the majority of visitors, can be sent to them.

CLEVELAND AND THE NORTHERN COUNTIES.

ONE HUNDRED YEARS OF SHIPBUILDING ON THE WEAR.—This is the centenary year of the Wear Shipbuilders Association. When the organisation was formed, there were about 45 shipyards on the Wear, and, in 1853, 152 ships aggregating 68,479 tons were launched. In those days vessels of from 400 to 500 tons were considered large, but, to-day, the Wear has facilities for building ships of up to 26,000 tons. There are now only eight shipyards on the river, but last year the output totalled 26 ships, making together upwards of 170,000 gross tons.

DUST NUISANCE FROM DUNSTON POWER STATION.—The British Electricity Authority are taking steps to remove the nuisance caused by grey dust from Dunston power station settling on property in the west-end of Newcastle-on-Tyne. Complaints have been made over a period of two years and the Authority have completed the first stage in their plan for adjusting the smoke-elimination plant at the power station. The second and final stage of the work will be completed by the end of next month.

CLOSING OF NEW BRANCEPETH COLLIERY.—The Durham Division of the National Coal Board has shut down New Brancepeth Colliery in accordance with its policy of closing uneconomic pits. Further closures are likely in North-West and Mid-West Durham. The number of employees at New Brancepeth has been gradually reduced during the past two years, and, at the time of closing, only 126 miners were left. More than 80 of these have found work elsewhere, but 30 are being retained for salvage work.

INDUSTRIAL DEVELOPMENT IN WEST CUMBERLAND.—At the annual meeting of the West Cumberland Industrial Development Co., Ltd., it was reported that factory additions covering 83,371 sq. ft. had been completed, or were in course of construction. It was reported that, during the year, extensions had been completed for West Cumberland Silk Mills, Ltd., Hensingham; Myers and Bowman, Ltd., Distington; and a new laboratory and extension for Electroflo Meters, Ltd., Maryport. Extensions were being carried out for the British Fez Co., Ltd., Frizington, and Marchon Products, Ltd., Whitehaven, and a new factory was proposed for Remploy, Ltd., Cleator Moor.

OPPOSITION TO WOODHORN-LYNEMOUTH MINERAL RAILWAY.—The proposed construction of a mineral railway between Woodhorn Colliery and Lynemouth Colliery, Northumberland, is to be raised in the House of Commons by Mr. R. J. Taylor, M.P. for Morpeth. The railway is planned by the Northern (Northumberland and Cumberland) Division of the National Coal Board, and there is considerable opposition to it locally, on the ground that it will interfere with the amenities of the district. The Board state that a suggested alternative route would be more costly to operate.

LANCASHIRE AND SOUTH YORKSHIRE.

RELICS OF A PIONEER MACHINE-TOOL DESIGNER.—The executors of Mr. Harry Liebert, a founder of the firm of John Holroyd & Co. Ltd., Milnrow, Lancashire, have presented to the company a silver medal and two bronze medals which were awarded at the Paris International Exhibition of 1900 for machine tools of his design. One of the original machines, a thread miller, is in the Science Museum, South Kensington.

WIDNES-RUNCORN BRIDGE.—Work on the single-span suspension bridge across the River Mersey and the Manchester Ship Canal, linking Widnes in Lancashire and Runcorn in Cheshire, is expected to start this autumn and to be completed in 1957. The span will be about 1,050 ft. and the bridge will carry a 24-ft. roadway and one 6-ft. footpath cantilevered outside the main structure. It will be built between the railway bridge and the transporter bridge, which it will replace.

LABOUR POSITION IN SHEFFIELD.—Sheffield's activity may be gauged from the fact that there are fewer persons out of work than at any other time this year. No women cutlery employees are without a post and, throughout Sheffield, only 61 women are on short time—the lowest for 18 months. The number of men on short time, namely 399, is 35 less than in the previous month and is the lowest this year. At least half the men on short time are in steelworks. The total of men wholly out of work is also falling and, at 1,246, is the lowest for a year.

EMPLOYMENT OF OVER-AGE MINERS.—The National Coal Board has accepted the suggestion of the Yorkshire branch of the National Union of Mineworkers that, before any miner who has reached the age of 65 is retired compulsorily, there should be consultations with his branch. Should there be no satisfactory solution at that stage, the matter would be taken to Board Divisional level.

HEAVY FORGINGS FOR HYDRO-ELECTRIC PLANT.—Progress is being made at the Sheffield works of the English Steel Corporation Ltd., with the execution of an order for four forged-steel transmission shafts for an underground hydro-electric power station in south-east Brazil. Each shaft is 21 ft. long and 34 in. in diameter, with flanges 42 in. in diameter. Each is being forged from an ingot having a section of 64 in., and weighing 60 tons. The generating plant for the scheme is to be housed in two power houses.

WORKS RADIO SYSTEM.—A system of radio communication already in use between shunting locomotives at the Steel Peech and Tozer Works, Rotherham, is to be extended to cover cranes and certain of the shops. It is claimed that smoother and swifter passing on of ingots from department to department will result.

THE MIDLANDS.

SUTTON COLDFIELD TELEVISION TRANSMITTING STATION.—The British Broadcasting Corporation's high-power vision and sound transmitters at Sutton Coldfield, which were the first of the high-power type to be brought into operation and have now been in continuous use for some 3½ years, are to be temporarily taken out of service for three to four weeks, beginning August 10, to enable them to be overhauled and various improvements to be made. During this period, the service will be carried by the medium-power stand-by transmitters. The high-power transmitters will be returned to service as quickly as possible. The date will be announced later.

PROGRESS ON THE LOWER AVON NAVIGATION.—Chadbury Lock, the third of the derelict locks on the River Avon between Tewkesbury and Evesham to be restored to a navigable condition, was opened on August 2. The restoration has been undertaken by the Lower Avon Navigation Trust, a non-profitmaking body formed in 1950 to make the waterway navigable once more, after it had been derelict for many years. Much of the work on Chadbury Lock, which has cost 4,000*l.*, has been done by a detachment of the Royal Engineers, as part of their training programme. Two more locks, Wyre and Fladbury, and a navigation weir at Cropthorne have still to be repaired before the river is fully navigable from its confluence with the Severn at Tewkesbury to Evesham.

LOCOMOTIVE WORKS EXTENSION.—W. G. Bagnall, Ltd., Castle Engine Works, Stafford, have brought into use a new erecting shop for Diesel locomotives. The new shop, which is 175 ft. long and 43 ft. wide, has two erecting tracks, one of which is of mixed gauge, and will accommodate locomotives of 5 ft. 6in., 4 ft. 8½ in., 3 ft. 6 in. and metre gauge. Two electric overhead travelling cranes, each of 50 tons capacity, have been installed.

ROAD WIDENING IN BIRMINGHAM.—Sanction has been given by the Minister of Transport to the scheme for widening the road through Digbeth and Deritend, Birmingham. The work, which will cost about 250,000*l.*, is expected to begin at once. The Digbeth-Deritend road, which leads from the city centre towards Coventry and the south, is one of the busiest routes in Birmingham, and in recent years has been seriously congested. At peak periods, vehicles have been taking more than half an hour to travel less than a mile.

STEELWORKS SMOKE PROBLEM SOLVED.—The emission of thick black smoke at Round Oak Steelworks, Brierley Hill, Staffordshire, which has been a source of local complaint for a number of years, has now ceased as a result of modernisation of the plant. A battery of hand-fired Lancashire boilers, which was the cause of the trouble, has now been taken out of service, and the boilers and chimney stack are soon to be demolished. Most of the plant in the steelworks is now electrically driven, and what steam is required is generated in waste-heat boilers, working in conjunction with new 125-ton open-hearth furnaces.

BLACK COUNTRY MOTOR-ROAD PLAN.—A recommendation of the County Roads and Bridges Committee for a motor-road in the Black Country has been accepted by Staffordshire County Council. The road is planned to incorporate the line of the Walsall-Western by-pass, and grade-separated junctions are proposed where it crosses the A. 41 road at West Bromwich, A. 4031 from West Bromwich to Walsall, A. 461 from Wednesbury to Walsall, A. 454 from Wolverhampton to Willenhall, A. 4124 from Wolverhampton to Wednesfield, and A. 460 from Wolverhampton to Cannock. These junctions are fairly close together, and it is considered that this will increase the value of the road for local traffic, as well as that proceeding straight through the area.

NEW BOREHOLES FOR WATER SUPPLY IN EAST WORCESTERSHIRE.—One of two boreholes at a new pumping station at Wildmoor, near Bromsgrove, Worcestershire, is now nearly complete. It is down to 600 ft., and about 200,000 gallons of water a day are flowing to waste while the work is proceeding. The new pumping station is being constructed for the East Worcestershire Waterworks Company to serve the Rubery and Barnt Green areas, near Birmingham. When it is completed, the daily yield will be 1,500,000 gallons, which will provide a surplus over present requirements.

SOUTH-WEST ENGLAND AND SOUTH WALES.

SOUTH WALES COAL INDUSTRY.—Holidays are taking a heavy toll of output in the South Wales coalfield, and shipment activities are in consequence being checked. In the week ended August 1, the total export to home and foreign destinations from the South Wales ports was only 99,598 tons, which was the poorest weekly total since that of March 8, when the figure was 94,801 tons. Preliminary figures of output for the week ended August 1 give a total of 340,529 tons which compares with 350,652 tons in the previous week. The loss of coal during the August Bank Holiday week will further aggravate the difficult supply position.

PRESCELLY WATER-SUPPLY RESERVOIR.—The Prescelly Water Board have been informed that detailed plans for the construction of the second dam and reservoir at Prescelly are nearing completion. The extensions are estimated to cost 376,000*l.* and will be shared by the four constituent authorities, namely, Milford Haven Urban, Haverfordwest Borough, Haverfordwest Rural District, and Tenby Borough Councils.

DISPOSAL OF COLLIERY WASTE.—The National Coal Board is finding difficulty in disposing of colliery waste in South Wales. Mr. C. E. M. Billingham, the area planning officer of the Board, told a meeting of Aberdare Town Planning Committee that spoil had been tipped on mountain sides and in valleys in South Wales and Monmouthshire to such an extent over the years that the Board now experience difficulty in finding places for waste.

LAUNCHES AND TRIAL TRIPS.

M.S. "MAID OF CUMBRAE."—Twin-screw passenger vessel, built by Ardrossan Dockyard, Ltd., Ardrossan, Ayrshire, for the Clyde service of the Scottish Region of British Railways, Glasgow. Main dimensions: 160 ft. by 28 ft. by 10 ft.; gross tonnage, 500. Two six-cylinder oil engines, constructed by British Polar Engines, Ltd., Glasgow. Service speed, 15 knots. Trial trip, July 10.

S.S. "BORDE."—Single-screw collier, built by S. P. Austin & Son, Ltd., Sunderland, for Stephenson Clarke, Ltd., London, E.C.3. Main dimensions: 344 ft. overall by 46 ft. by 22 ft. 4 in. to upper deck; deadweight capacity, about 4,600 tons on a mean summer draught of 20 ft. Direct-acting triple-expansion engine of reheat design, constructed and installed by the North Eastern Marine Engineering Co. (1938), Ltd., Sunderland, and two oil-burning boilers. Trial speed, 11½ knots. Trial trip, July 20.

M.S. "THEBEN."—Single-screw cargo vessel, with accommodation for twelve passengers, built and engined by Eriksbergs Mekaniska Verkstads A/B, Gothenburg, Sweden, for Wilh. Wilhelmsen, Tönsberg, Norway. Main dimensions: 470 ft. by 65 ft. by 43 ft.; deadweight capacity, 10,460 tons. Eriksbergs-Burmeister and Wain oil engine, developing 11,400 i.h.p. and a speed of 18 knots. Launch, July 21.

M.S. "RAPHAEL."—Single-screw cargo vessel, with accommodation for six passengers, built by Bartram and Sons, Ltd., Sunderland, for the Lamport and Holt Line, Ltd., Liverpool. Main dimensions: 440 ft. between perpendiculars by 61 ft. 9½ in. by 39 ft. to shelter deck; deadweight capacity, 10,050 tons on a draught of 28 ft. 4½ in. N.E.M.-Doxford six-cylinder two-stroke opposed-piston oil engine, developing 7,500 b.h.p. at 115 r.p.m. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Speed on trial, 17½ knots. Trial trip, July 23.

M.S. "PEARLSTONE."—Single-screw cargo vessel, built by Short Brothers, Ltd., Sunderland, for the Alva Steamship Co., Ltd., London, E.C.3. Main dimensions: 438 ft. between perpendiculars by 59 ft. 9 in. by 37 ft. 7 in. to shelter deck; deadweight capacity, about 10,000 tons on a mean summer draught of 25 ft. 9½ in.; gross tonnage, 5,700. N.E.M.-Harland and Wolff-Burmeister and Wain six-cylinder opposed-piston single-acting two-stroke oil engine, developing 4,400 b.h.p. at 115 r.p.m., installed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Service speed, 13 knots. Trial trip, July 23.

S.S. "ALIKI LIVANOS."—Single-screw two-deck cargo vessel, built and engined by William Gray & Co., Ltd., West Hartlepool, for Mr. N. G. Livanos, Piræus, Greece. Main dimensions: 431 ft. between perpendiculars by 57 ft. 6 in. by 38 ft. 3 in. to upper deck; deadweight capacity, 11,235 tons on a draught of 28 ft. 6¼ in. Vessel constructed so as to carry 10,000 tons deadweight on a draught of 26 ft. 7 in. when operating with open shelter deck. Triple-expansion steam engine, working in conjunction with a Bauer-Wach exhaust turbine, and three oil-fired boilers. Service speed, 11½ knots. Trial trip, July 24.

S.S. "HEMIDONAX."—Single-screw oil tanker, built and engined by Cammell Laird & Co., Ltd., Birkenhead, for the Anglo-Saxon Petroleum Co., Ltd., London, E.C.3. Main dimensions: 530 ft. by 69 ft. 3 in. by 39 ft.; deadweight capacity, 18,000 tons on a draught of 29 ft. 7 in. Double-reduction geared steam turbines developing 8,250 s.h.p. Launch, July 28.

M.S. "LUSTROUS."—Single-screw oil tanker, built by Smith's Dock Co., Ltd., South Bank-on-Tees, for H. E. Moss & Co., Liverpool. Third tanker built for these owners. Main dimensions: 528 ft. 10 in. overall by 69 ft. 6 in. by 38 ft.; deadweight capacity, about 16,700 tons on a draught of 29 ft. 10 in. Hawthorn-Doxford five-cylinder two-stroke opposed-piston oil engine, developing 5,500 b.h.p. at 112 r.p.m., in service, constructed by R. and W. Hawthorn, Leslie & Co., Ltd., Newcastle-upon-Tyne. Service speed, 13½ knots. Launch, July 28.

S.S. "IRISH ELM."—Single-screw cargo vessel, built and engined by William Gray & Co., Ltd., West Hartlepool, for Irish Shipping, Ltd., Dublin. First of a series of six vessels for these owners. Main dimensions: 410 ft. between perpendiculars by 58 ft. by 37 ft. 8 in. to shelter deck; deadweight capacity, about 8,800 tons on a draught of 25 ft. 11½ in. Triple-expansion steam engine, working in conjunction with a Bauer-Wach exhaust turbine, and three oil-fired cylindrical boilers. Service speed, 12½ knots. Launch, July 29.

S.S. "CORMOOR."—Single-screw collier, built by Hall, Russell & Co., Ltd., Aberdeen, for Wm. Cory and Son, Ltd., London, E.C.3. Main dimensions: 320 ft. between perpendiculars by 46 ft. by 22 ft. 4 in.; gross tonnage, 3,374. Direct-acting triple-expansion steam engine of reheat design, developing 1,100 i.h.p. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Sunderland; and two cylindrical coal-burning boilers. Trial trip, July 31.

BRITISH STANDARD SPECIFICATION.

THE following publication of engineering interest has been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 24, Victoria-street, London, S.W.1, at the price quoted in the text.

Cartridge Fuse-Links for Use in Plugs.—A revision of B.S. No. 1362, covering cartridge fuse-links rated at 250 volts and up to 13 amperes and primarily for use in plugs for domestic circuits, has just been issued. The most important feature of the revision is the increase of the breaking capacity rating from 1,000 amperes to 6,000 amperes. In specifications which include requirements for fuses up to the largest sizes, current ratings and the like are assigned only to fuses, and not to cartridge fuse-links, because cartridge fuse-links are not necessarily interchangeable in fuses of different types without alteration of the characteristics of the fuses. In fuses of the comparatively small current ratings dealt with in the present specification, however, the influence of the surroundings of the cartridge fuse-links is small, and it has therefore been deemed appropriate to make the specification apply to cartridge fuse-links only, giving them current ratings and the like exceptionally. The specification will be extended in due course to cover the use of these cartridge fuse-links in direct-current circuits. Discriminations between fuse-links of different current ratings has not been dealt with in this specification because the problem has not yet been fully solved. It continues to be investigated, however, and an addition to the specification will be made in respect of it as soon as possible. The present revision contains sections on definitions, voltage rating, current ratings and dimensions of fuse-links, breaking-capacity rating, fusing factor, and marking. A section on tests, with diagrams of the testing enclosure and connections for tests, is included. [Price 2*s.* 6*d.*]

CONTRACTS.

DECCA RADAR LTD., 1-3, Brixton-road, London, S.W.9, have received a contract from the authorities of the Newcastle Municipal Airport, Woolsington, to supply and install their airfield radar type 424. This will enable aircraft to be landed under conditions of poor visibility and will also enable an area within 25 miles of the airfield to be searched continuously for aircraft.

BRITISH INSULATED CALLENDER'S CABLES, LTD., have received an order for a 2,500-kVAr capacitor bank to be supplied to the Electricity Commission of New South Wales, Australia. The bank will comprise nine 250-kVAr single-phase units, which will be suitable for connection in star on an 11-kV 50-cycle three-phase system.

VICKERS-ARMSTRONGS LTD., Vickers House, Broadway, London, S.W.1, have received an order from Iraqi Airways for three of their Viscount propeller-turbine air liners. This brings the total of Viscounts ordered to 84.

THE DE HAVILLAND AIRCRAFT CO., LTD., Hatfield, Hertfordshire, have received a repeat order from Air France for three series 2 Comet air liners. These are powered by Rolls-Royce Avon jet turbines and are to be delivered early in 1955. The aircraft will operate stage lengths exceeding 2,000 miles when carrying a payload of 13,500 lb. Its all-up weight is 120,000 lb., and it carries 44 passengers.

THE WESTINGHOUSE BRAKE AND SIGNAL CO., LTD., 82, York-way, King's Cross, London, N.1, have been awarded the contract for the re-signalling of Cowlairs, Glasgow, on the Scottish Region of British Railways. The installation, at present operated from eight mechanical signal boxes, will be replaced by a control desk and diagram in one central signal box. It will include multi-aspect colour-light signals and junction and route indicators. The whole installation covers approximately 14 track miles.

THE NATIONAL GAS AND OIL ENGINE CO., LTD., Ashton-under-Lyne, have received an order from Alexander Stephen and Sons, Ltd., Linthouse, Glasgow, for the whole of the machinery for a twin-screw ferry boat to be built for the Canadian Pacific Railway to ply between Vancouver and Nanaimo. The order includes four main propelling engines, three large auxiliary units and an emergency unit. The vessel will be of 7,000 tons and designed to carry 800 passengers and 28 railcars or from 110 to 120 motor cars. Each of the twin screws will be coupled to two National B4AUM 7 engines fitted with Vulcan Sinclair scoop-controlled hydraulic couplings.

THE METROPOLITAN-VICKERS ELECTRICAL CO., LTD., Trafford Park, Manchester, 17, have received an order, valued at 3,500,000*l.* for the supply of three 20,000 kW. turbo-generator sets and other equipment for the Catalagzi power station, Turkey.

PERSONAL.

AIR CHIEF MARSHAL SIR JOHN W. BAKER, K.C.B. M.C., D.F.C., has been appointed Controller of Supplies (Air) at the Ministry of Supply, in succession to AIR MARSHAL SIR JOHN M. BOOTHMAN, K.B.E., C.B., D.F.C., A.F.C., with effect from October 15, 1953.

SIR CYRIL BIRTCHNELL, K.C.M.G., C.B., Deputy Secretary to the Ministry of Transport, is retiring from the public service in September. His successor is to be MR. P. D. PROCTOR, C.B.

MR. IVAN M. WALLER, B.A., M.I.Mech.E., has joined the Lockheed Hydraulic Brake Co. Ltd., to assist, in the first instance, with the development of the Lockheed-Avery flexible pipe and self-sealing couplings division.

MR. H. W. GRIMMITT, M.I.E.E., A.M.I.Mech.E., at present deputy chief engineering inspector in the Electricity Division of the Ministry of Fuel and Power, has been promoted to be chief engineering inspector, with effect from September 1, in succession to MR. A. N. EAST, C.B.E., M.I.E.E., M.I.Mech.E., A.I.C.E., who retires on that date.

COMDR. (L) C. V. ROBINSON, O.B.E., R.N., has been elected chairman of the Southern Centre of the Institution of Electrical Engineers for 1953-54, in place of MR. C. A. W. PRIEST, B.Sc. (Eng.), A.M.I.Mech.E., M.I.E.E., who, as stated on page 175, *ante*, has been appointed chief generation engineer (construction) of the South Wales Division of the British Electricity Authority.

MR. JOHN BRANCKER, general manager international affairs, British Overseas Airways Corporation, since 1951, has been appointed traffic director, International Air Transport Association, International Aviation Building, Montreal, 3, Canada.

DR. N. H. MACKWORTH has been appointed director of the Applied Psychology Research Unit of the Medical Research Council, 15, Chaucer-road, Cambridge, as from October 1, in succession to SIR FREDERIC BARTLETT, who retires on that date.

MR. C. C. BATES, M.I.W., A.M.I.P.E., has been appointed chief welding engineer of Costain-John Brown, Ltd., 73, South Audley-street, London, W.1.

MR. C. F. DICKSON, O.B.E., has joined the board of Skyways, Ltd., 7, Berkeley-street, London, W.1.

MR. THEODORE BERRY, A.M.I.Mech.E., A.M.I.Mar.E., works manager, Drysdale & Co. Ltd., Bon-Accord Works, Yoker, Glasgow, W.4, has been appointed a director of the company.

MR. F. G. WOOLLARD has retired from the boards of the Birmingham Aluminium Casting (1903) Co., Ltd., and the Midland Motor Cylinder Co., Ltd.

MR. K. BYARD, technical manager in Durban to the Dunlop Rubber Co. Ltd., has succeeded MR. A. T. ROBERSON, now general works manager at Speke, as Dunlop works director in South Africa.

MR. F. R. SALMON, agent to "E" group of collieries, No. 6 area of the Durham Division, National Coal Board since 1950, has resigned to take an appointment overseas with Mitchell, Cotts & Co. Ltd.

MR. P. B. H. BROWN, managing director of L. Sterne & Co. Ltd., refrigerating engineers, Glasgow, has been appointed vice-chairman of the board.

MR. T. E. DANIEL, deputy chairman of the North Eastern Electricity Board since nationalisation, is to take up a similar post with the North-Western Electricity Board.

MR. A. D. MACKAY, managing director of the Bergius Co., Ltd., Glasgow, has been appointed deputy chairman to Henry Meadows, Ltd., Fallings Park, Wolverhampton.

MR. A. R. MCCOSH has been appointed a director of William Baird & Co., Ltd., Glasgow.

MR. R. E. GRAY, of 250, Cowdray-avenue, Colchester, Essex, has been appointed a technical sales representative with Jenolite Ltd., 43, Piazza-chambers, Covent Garden, London, W.C.2.

THE ENGLISH ELECTRIC CO., LTD. have agreed to buy, from CABLE AND WIRELESS, LTD., the latter's interest, amounting to 50·6 per cent. of the share capital, in the CANADIAN MARCONI CO.

THE OWEN ORGANISATION OF GREAT BRITAIN have recently established a new company, RUBERY, OWEN CANADA, LTD., 1470, The Queensway, Postal Station N., Toronto, 14, under the management of MR. B. S. MALE.

MONKS AND CRANE, LTD., Birmingham, have opened a Scottish branch at 79, Crown-street, Glasgow, C.5 (Telephone: South 2907). The manager is MR. A. MCCABE.

THE NORTH BRITISH RUBBER CO., LTD., Edinburgh, and the DOMINION RUBBER CO., LTD., London, announce that the sales and branch service organisations of the two companies will be consolidated. The North British Co. will undertake the distribution of both firms' products in the United Kingdom, and the Dominion Rubber Co. the distribution of both firms' product overseas.

MANIPULATION OF SEAMLESS TUBES: ACCLES AND POLLOCK, LTD., OLDBURY.

(*For Description, see Page* 193.)

FIG. 7. DRILLING WELDED COMPONENTS.

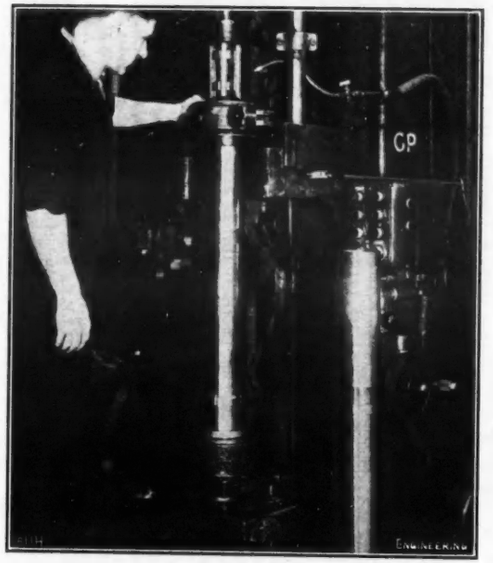


FIG. 8. BARNESDRILL HONING MACHINE.

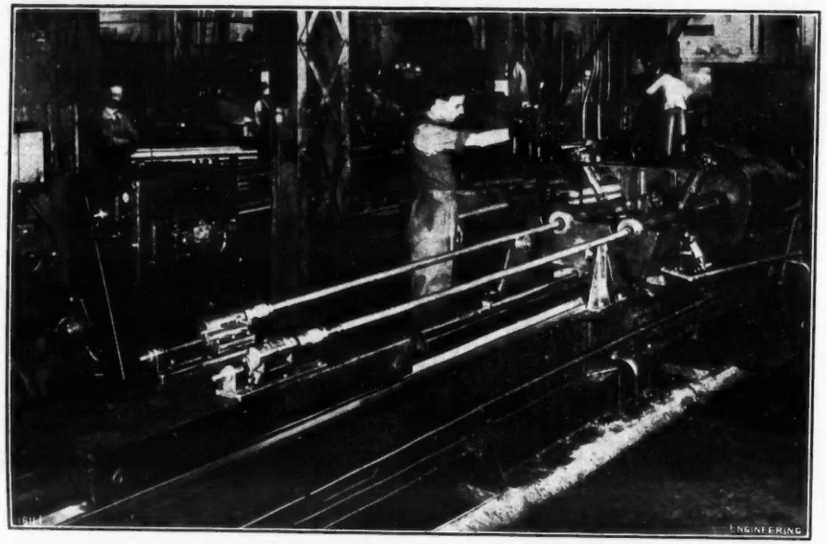


FIG. 9. BROOKES DOUBLE-HEAD TUBE-HONING MACHINE.

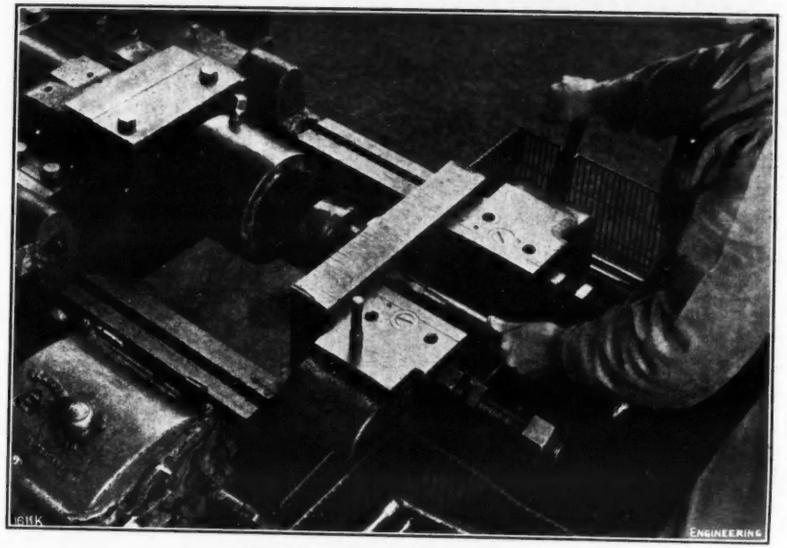


FIG. 10. FORMING BOX SPANNERS.

ENGINEERING

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We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and any other publication bearing a similar title.

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Telephone Numbers:

TEMPLE BAR 3663 and 3664.

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Accounts are payable to ENGINEERING Ltd. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

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For Canada	£5 5 0

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Terms for displayed advertisements can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2¼ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

The charge for advertisements classified under the headings of "Appointments Open," "Situations Wanted," "Tenders," etc., is 10*s.* for the first four lines or under, and 2*s.* 6*d.* per line up to one inch. The line averages six words and when an advertisement measures an inch or more, the charge is 30*s.* per inch. If use is made of a box number the extra charge is 1*s.* per insertion, with the exception of advertisements appearing under "Situations Wanted." Series discounts for all classified advertisements can be obtained at the following rates:—5 per cent. for six; 12½ per cent. for thirteen; 25 per cent. for twenty-six; and 33⅓ per cent. for fifty-two insertions.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be received not later than first post Monday.

"Copy" instructions and alterations to standing advertisements for display announcements must be received 16 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

The Proprietors will not hold themselves responsible for advertisers' blocks left in their possession for more than two years.

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PLATE.

Plate XII.—ENGINEERING HALL AT THE BIRMINGHAM MUSEUM OF SCIENCE AND INDUSTRY.

ENGINEERING

FRIDAY, AUGUST 14, 1953.

VOL. 176. No. 4568.

MECHANICAL ENGINEERING RESEARCH.

THE Mechanical Engineering Research Board, which was set up in December, 1946, in one of its early reports stated that the work of the research organisation which it was appointed to administer not only "will assist in accelerating the advance of the mechanical engineering industry in this country," but "will also be of great service in the practice of civil engineering, electrical engineering and chemical engineering." The shipbuilding industry might have been added to this list. Work on the properties and strength of materials, on the mechanics of fluids and on lubrication and corrosion, is of value and importance in every sphere in which engineering materials are used in structures or machines. Some of the researches now in progress are likely to be of value not only in the broad field represented by the title of this journal, but in every branch of scientific investigation; an example is furnished by the work on the performance of instrument gears.

When it was decided that work in the field of mechanical engineering should be transferred from the National Physical Laboratory to East Kilbride, near Glasgow, it was envisaged that the new establishment should ultimately accommodate a total staff of 600 to 700. This figure is as yet far from being achieved and the latest report* of the Board states that at the end of December, 1952, the total was 245, of whom 96 were scientific and experimental officers and 28 ancillary laboratory workers. The staff increased by 50 during the year. No doubt there are difficulties, affecting individuals, in arranging for transfer from Teddington to East Kilbride, although the East Kilbride Development Corporation has been able to provide houses for transferred members. However, matters have evidently been satisfactorily arranged and all members of the staff of the laboratory are now in Scotland.

All organisations engaged in scientific research are having difficulty in recruiting senior staff members, but the rate of progress of the Kilbride establishment would appear to be to a considerable extent determined by delay in the building programme. This has led to the major part of the work on high-temperature creep and fatigue still being carried out at the National Physical Laboratory. Apart from this, however, it is clear that work at East Kilbride is being hampered by inadequate accommodation. It had, for instance, been hoped that work on the heat-transfer laboratory would start in 1951, but it has been postponed to the financial year 1954-55. This is one of several items in which delay has occurred in the building programme.

The East Kilbride site has an area of 70 acres and it was originally intended that it should ultimately contain a boiler house, electrical substations, a central workshop, a canteen, an administrative building and eleven separate laboratories. The complete programme of research has from the first been planned under six headings, and in spite of restricted accommodation it is clear from the latest report that much is being done in all the divisions into which the research work is divided. As, however, the divisions dealing with the properties and strength of materials, stress analysis and vibration, the mechanics of fluids, the mechanics of formation and machine shaping, and heat transfer and applied thermodynamics are all at present accommodated in a single laboratory, it is clear that this building must be, in the words of the report, "uncomfortably crowded." The difficulties of the move to East Kilbride have been to some extent eased by the setting up of temporary premises at Thorntonhall, a few miles away. The division dealing with lubrication, wear and mechanical engineering aspects of corrosion has been accomodated at this site for 3½ years. Facilities have recently been increased there by the erection of temporary buildings.

In view of the field of activity covered by the term "mechanical engineering," and the range of the programme on which the organisation has embarked, any selection of particular researches, for mention, must be arbitrary. The report contains a list of work in progress during 1952; it contains 93 items. Of these, some few are extra-departmental researches carried out at various universities, but even when they are subtracted the total remains formidable. Sir Andrew McCance, the chairman of the board, in his section of the report refers to "short-term tests and special investigations for industrial firms and for the Admiralty and Ministry of Supply" occupying a good deal of time. There does not appear to be any complaint, of the type not uncommon in research reports, to the effect that the necessity for undertaking *ad hoc* researches interferes with the prosecution of fundamental work, and it is stated that "a large part of the programme is recognised by the Defence Departments as directly contributing to re-armament." None the less, experimental work on the pumping of peat for the Department of Agriculture for Scotland, although no doubt properly falling within the sphere of the division dealing with the mechanics of fluids, is a specialised matter

* *Report of the Mechanical Engineering Research Board with the Report of the Director of Mechanical Engineering Research for the Year* 1952. H.M. Stationery Office. [Price 2*s.* 6*d.* net.]

which would hardly be undertaken during research on size and scale effect in hydraulic machinery.

There is no need to speculate about the relative importance of the work of the divisions to the engineering industry generally, but the investigation on the behaviour of materials under fatigue loading must occupy a prominent position in any comparative estimate. This is a matter which has occupied the attention of many workers and has been in no way neglected in the past, but as the report states that "it is estimated that at least 90 per cent. of the failures of high-speed machinery are due to fatigue," it is clear that there is still room for much work on the subject. The matter is of particular importance in the aircraft industry. It is stated that the fundamental physical nature of fatigue is not fully understood. An extra-departmental research is being carried out at the University of Bristol in which electron-microscope and X-ray techniques are being used to study the slip-band field in metallic crystals under reversed loading cycles.

The subject is being approached at East Kilbride in a different way. It has been pointed out that worked surfaces emit particles capable of actuating an open-ended Geiger counter. This matter has been investigated by the division dealing with lubrication and wear. It has been assumed that the particles are electrons, but the investigations carried out have led to the tentative hypothesis that they are charged ions arising from the process of oxidation. This study is clearly in a preliminary stage, but it is hoped that light may ultimately be thrown on the physical nature of wear and fatigue strength. Work on fatigue in the strength-of-materials division has shown that, for some materials, the behaviour of large components containing stress concentrations can be fairly accurately predicted from direct push-pull tests and an elastic stress-concentration factor which can be determined experimentally.

One of the researches in progress in the mechanics-of-fluids laboratory is a study of the size and scale effect in hydraulic machinery. It will necessitate accurately-controllable rates of flow of 30 cub. ft. per second or higher, and for this and other purposes various types of control valves are required. It is stated that surprisingly little has been published about the behaviour of control valves or even about the flow patterns in them. Three special valves have been designed in the laboratory and some particulars about them are given. In one case the valve is required to control the discharge from pumps under test and to dissipate energy up to a rate of 350 h.p. The resistance across the valves has to vary from 30 to 600 ft. head of water. The arrangement proposed is a perforated cylinder with the axis vertical, an inner sleeve controlling the number of holes covered or uncovered. Experiments with a 4-in. model have shown that this design meets the requirements except at the highest rates of flow, at which linear characteristics do not hold. As the three types of valve which have been developed may be of industrial importance, it is proposed to publish detailed descriptions of them.

The two pieces of work mentioned above give an inadequate idea of the range of investigation being covered at East Kilbride. That can only be appreciated by a study of the report, but it may be mentioned, in addition, that investigations are in hand on thrust bearings operating at speeds up to 16,000 r.p.m. and that, in view of gas-turbine developments, work on journal bearings up to speeds of 50,000 r.p.m. is under consideration. In connection with the same developments, the operation of rolling bearings at a temperature of 250 deg. C. has been studied. Much work has been done on spur and helical gears, and the relative merits of shaved and hob-cut gears have been investigated. Finally, an elaborate study of the engineering and physical aspects of cavitation has been planned.

OIL REFINING IN EUROPE.

It is possible that, in the minds of some European taxpayers, the Organisation for European Economic Co-operation—"O.E.E.C."—may arouse the same sort of jaundiced feelings that were inspired in many by the thought of the League of Nations, with its impressive building and staff, and its innumerable reports and other publications; but the fact remains that the O.E.E.C. has been the means of gathering large quantities of statistical data of considerable economic value, which would have been difficult for any other organisation to compile. An excellent example of its work is the latest (the Third) Report on the Co-ordination of Oil Refinery Expansion in the O.E.E.C. Countries.* Clear, factual and up to date—the figures cited are brought down to the end of 1952—it presents a most informative survey of developments which, in a vague way, are probably common knowledge to many observers (since an oil refinery is usually a fairly obvious feature of the landscape) but which, in their full significance, are by no means so widely appreciated. The reader of this report may be forgiven, in fact, if he concludes that the loss of the refining capacity of Abadan, which seemed such a severe economic setback at the time, was actually beneficial in the long run as a stimulus which has had far-reaching effects on European security, both military and financial.

Before the war, it is stated, the annual internal consumption of petroleum products in Europe was a little over 26 million metric tons a year and the deliveries of bunker oil about 5 million tons. Of this total, the consumption of petrol—12·2 million tons—represented about 40 per cent. In 1952, the total consumption had risen to 69·4 million tons. It is still rising, and at such a rate that the expectation is that, in 1953, oil products will represent about 14·1 per cent. of the total sources of energy in Europe, as compared with about 13·5 per cent. in 1952. When it is borne in mind that the construction of thermal power stations and of hydro-electric plants is proceeding also at a rate hardly visualised even ten years ago, it will be seen that the power likely to be available per head of the population in a few years' time, by comparison with pre-war figures, should be a major factor in the increase of productivity, on which so much stress has been laid.

The figure of 69·4 million metric tons in 1952, quoted above, is an impressive one, but, of course, it is still modest by comparison with the consumption of the United States, which, in 1951, used 118 million tons of "gasoline" alone, 75 million tons of it for the propulsion of private motor-cars and motor cycles; the whole of Europe, in the same year, consumed only 5¾ million tons for that purpose. It is thought, however, that the total European consumption of petroleum products may well increase to 75 million tons in 1953, and 85 millions in 1956. If, therefore, the expansion of refining capacity can be continued to the point of making Europe more or less self-sufficient in that respect, the result should be to ease considerably the international financial position of most of the European countries associated in the Organisation, apart from the economic benefits to be expected from the construction of the refineries, by reason of the employment that it provides.

Much advantage is expected to accrue from the policy of locating refineries near the points of consumption in Europe instead of at the sources of supply. The closing of the Abadan refinery in 1951 added considerably to the load on the existing European refineries, but they rose to the occasion remarkably well, though at some extra cost. There are now signs that the upward curve of consumption is tending to flatten out, which makes it important that any new capacity contemplated should be planned with a view to long-term and economic outlets. It is stated that, at present, no large-scale development for processing aviation-spirit components is contemplated, even though the state of supplies is described as "somewhat precarious." It may be supposed, though the report does not state as much specifically, that the acceptance of the present situation is not unconnected with the growing use of jet engines for aircraft propulsion and the consequent prospect that the demand for aviation spirit may be regarded as having reached its probable peak or being somewhere near it.

The extra load resulting from the closing of the Abadan refinery revealed that the existing refinery capacity in Europe possessed a greater flexibility of output than had been supposed. The annual throughput before the war was about 13·5 million tons, and this was only barely succeeded so recently as 1947. The first report on oil-refinery expansion, published in 1949, estimated that, for the twelve months ending in June, 1953, the annual throughput would have risen to 62·4 million tons. The second report, published in August, 1951, confirmed that estimate, with a possible margin of another 10 million tons; but in fact, by the end of 1952, the actual throughput had practically reached the maximum potential level previously envisaged for the year ending June, 1953, and it is expected that, by the end of 1953, this level will have been exceeded by more than 10 million tons. If this is accomplished, European refineries will be responsible for about 13 per cent. of the world output; before the war, Europe's share was about 5 per cent. It is pointed out, however, that the location of refineries is not decided only on the basis of market requirements in a particular area, but must be influenced also by such factors as political and labour conditions; and that, because of the international character of the industry and the existence of competition—which is keener and more general than is commonly believed by the general public—national governments may not always find it desirable to eliminate imports. Neither will the refiners, if the quantities of particular products likely to be required are small.

The number of European refineries listed is a feature of some interest. Taking the countries mentioned in alphabetical order, Belgium has seven; Denmark, one; France, 13; Germany, 20 specified by name, and some small plants, not named individually; Italy, 31, and another projected; the Netherlands, two; Norway and Portugal, one each; Sweden, two; Switzerland and Turkey, one each; and the United Kingdom, 15—a total of 95, with another in prospect in Italy. Many of them, of course, are of relatively small capacity, by modern standards; but 33 have distillation capacities of more than a million metric tons per annum each, and 11 can handle three million tons or more.

The largest plant in Europe is the Pernis plant at Rotterdam, owned by the Royal Dutch Shell group, which can distil 8,750,000 tons a year; the Esso installation at Fawley, Hampshire, comes second, with 8,300,000 tons. The United Kingdom has three other plants—the one at Stanlow, owned by the Shell organisation, and the Llandarcy and Kent refineries, owned by the Anglo-Iranian Oil Company—which range from 4 to 4·2 million tons. France has the only other one in Europe with a capacity of four million tons or more, namely, that of the Esso Standard group at Port-Jérome, which can handle 4·2 million tons a year. It will be seen, therefore, that the United Kingdom has developed quite rapidly into the position of being the leading oil-refining country in Europe, with a distillation capacity which, by the end of 1954, will amount to practically 30 million metric tons a year.

* Published by the Organisation for European Economic Co-operation, 2, Rue André-Pascal, Paris 16e, and obtainable from H. M. Stationery office, York House, Kingsway, London, W.C.2.

NOTES.

PLANT FOR PRODUCTION OF TITANIUM.

TITANIUM, from the designer's point of view, is attractive because of its light weight, or, more accurately, its high strength-to-weight ratio. It has other possibilities too, which were reviewed by Major P. L. Teed a few months ago (ENGINEERING, vol. 175, pages 251, 341 and 413 (1953)); the same author is to present a paper on the subject at the British Association meeting next month, and this paper will be published in ENGINEERING. The cost of titanium is high, owing to the technical difficulties of refining and working it, but although this is bound to restrict its use there are engineering applications, especially in aircraft, where it is worth paying the high price for the sake of the properties of the material. There is a period ahead for titanium during which far-seeing engineers and metallurgists will explore its possible applications and develop its economical production. An announcement by the Ministry of Materials makes it clear that the production side of the business is now on a firm footing. They have concluded a contract with Imperial Chemical Industries, Limited, under which this firm will erect, at their own expense, plant to produce 1,500 tons of sponge titanium a year. The firm will also instal plant for converting this metal to ingot form, and they expect production to begin in two years' time. The Ministry have undertaken to buy directly up to three-quarters of the company's output of sponge titanium over the first four years of production if the metal is not otherwise sold in various forms for use by Government contractors, and the Ministry have an option on the full output if it is needed for defence purposes. The price of the metal will be equivalent to the world price current at the time of purchase. It is understood that I.C.I. already have in course of erection pilot plants which will begin to produce at the rate of 150 tons per annum early in 1954.

ULTRASONIC INSPECTION OF WELDS.

A demonstration of the use of ultrasonic methods for examining the welds in the pressure vessels and other chemical engineering equipment manufactured by them was recently given by Messrs. W. J. Fraser and Company, Limited, at their works at Monk Bretton, near Barnsley. As fabrication by welding becomes both more widespread and more complex, non-destructive testing becomes more complicated, occupies more time, and is more expensive. Ultrasonic methods help to overcome these difficulties, and although they are not yet recognised in most codes of practice, they have been applied by Messrs. Frasers to such good effect that a high level of quality can be ensured by their employment. As is well known, the method used for this purpose is to inject pulses of ultrasonic frequency into the metal under test from piezo-electric quartz probes, which are in turn set in mechanical vibration by an oscillator to give vibrations with a frequency of between one and five megacycles. Echoes, picked up by similar probes, are converted into electrical signals and are shown, after amplification, on the screen of a cathode-ray tube. The echoes due to the far side of the material or to internal flaws appear as "flips" on the screen and their relative positions enable the presence of the flaws to be detected. The apparatus used for this purpose at Monk Bretton was supplied by Messrs. Kelvin and Hughes (Industrial), Limited, Caxton House, London, S.W.1, and full details of it were given on page 363 of our 175th volume (1953). Other equipment used was manufactured by Glass Developments, Limited, Brixton Hill, London, S.W.2. The successful employment of electronics for this purpose demands considerable skill, as the operator must be able to recognise from past experience the nature and extent of the flaw that is being indicated. A complete examination also takes considerable time, but actually this is seldom required as once the size and distribution of the defect have been established a probing sequence can be devised which enables a square yard of plate to be inspected in from 15 to 20 minutes. This time depends on the size of the defect and the ease with which the probes can be moved over the plate. It is found, too, that two probes fixed relative to each other give good results, any loss in efficiency being outweighed by the fact that fewer variables are left to the operator. Difficulties in identification, owing to the complicated shapes encountered in practice, can be overcome either by radiographic methods or by preparing welds deliberately incorporating certain defects and thus building up a "reference library." The demonstration clearly indicated the important part that this method can play in ensuring the soundness of welds. Messrs. W. S. Atkins and Partners, 158, Victoria-street, London, S.W.1, were the consultants in the establishment of the ultrasonic weld-inspection department.

COASTAL FLOOD WARNING SYSTEM: INTERIM REPORT.

The interim report of the Committee on Coastal Flooding, set up by the Government after the serious flooding in the eastern coastal areas at the end of January last, has just been published. The committee was appointed on April 28 last, under the chairmanship of Viscount Waverley. The terms of reference were:—"To examine the causes of the recent floods and the possibilities of a recurrence in Great Britain; to consider what margin of safety for sea defences would be reasonable and practicable, having regard, on the one hand, to the estimated risks involved and, on the other, to the cost of protective measures; to consider whether any further measures should be taken by a system of warning or otherwise to lessen the risk of loss of life and serious damage to property; to review the lessons to be learned from the disaster and the administrative and financial responsibilities of the various bodies concerned in providing and maintaining the sea defences and replacing them in the event of damage, and to make recommendations." The floods were caused by the combination of a fairly high tide of the ordinary type, with a very high rise of sea-level, due mainly to exceptionally strong winds over the North Sea. These two phenomena were entirely unrelated, and the maximum height of the "surge," or rise in sea-level independently of tidal conditions, occurred within 3½ hours of the predicted time of high water for this ordinary tide. No evidence was found of any periodicity in the occurrence of such a combination of phenomena; but the report adds that, although such a combination of surge and tide may not occur again for many years, it may, nevertheless, occur next winter. In regard to a warning system, a sub-committee has been formed to consider the general question of forecasting tidal surges and has recommended that studies should be carried out in the English Channel, the Bristol Channel and the Irish Sea, as it may be necessary to extend the scope of the warning system. For the present, however, it is recommended that the system should be confined to the East Coast and that it should operate between September 15 and April 30 each winter. The committee recommend that a warning system should be based on the Central Forecasting Office at Dunstable, to which representatives of the Hydrographic Department should be detailed for duty during the warning period, since, while the meteorologist can predict conditions favourable for the occurrence of a surge, only the hydrographers, by comparing their predicted levels with the actual levels reported by the harbour masters, can give any indication of the height to which a surge will reach at any particular point. It is also recommended that tidal guages should be set up at Aberdeen, Leith, the Tyne entrance, Immingham, Lowestoft and Harwich. To read these gauges, it is proposed, that a staff should be available at three hours' notice, day and night.

INTERNATIONAL ELECTROTECHNICAL COMMISSION.

An official announcement has been received regarding the proceedings at the meeting of the International Electrotechnical Commission, which was held at Opatija in Yugoslavia from Monday, June 22, to Wednesday, July 1. About 300 delegates from 17 countries attended, the largest delegation consisting of the 43 members of the British National Committee. The president was Dr. H. S. Osborne of the United States. Lists of symbols of general application and relating specifically to terminals and brushes of rotating machines and to transformers were discussed, and revised lists are to be prepared for consideration at the next meeting. A sub-committee was set up to prepare a scheme of classification for diagrams of connections. Agreement was reached on many of the proposals put forward on methods of measuring the characteristics of broadcast television receivers and a document on the procedure for applying basic climatic and mechanical robustness tests to radio components was approved for publication. A sub-committee on high-frequency cables and connectors was appointed and it was decided to undertake the study of piezo-electric crystals with a view to the preparation of a specification. The question of the standardisation of radio transmitters was also discussed. The methods of testing insulating materials for tracking, volume and surface resistivity and heat resistance were reviewed and the final texts of the rules for short-circuit conditions in switch and control gear were approved for publication. A document dealing with the unit testing of circuit-breakers for making and breaking capacity has been circulated to the National Committee for approval. The specification for tests on impregnated paper-insulated lead-covered cables for voltages from 10 kV to 66 kV has been completed and draft specifications for mercury arc rectifiers, fluorescent lamps and electronic valves are being circulated. A draft resolution on the rationalisation of the M.K.S. system of units was also adopted for circulation. It was decided to institute an annual lecture in commemoration of the valuable work done by the late Mr. C. Le Maistre as general secretary of the Commission since 1904.

ROYAL GREENWICH OBSERVATORY.

The Admiralty state that the first stage of the transfer of the Royal Observatory from Greenwich to Herstmonceux Castle, in Sussex, has been completed. This stage consisted of the adaptation of the Castle and the construction of the solar building and spectroheliograph cellar. Provision has been made for administrative offices, library, instrument rooms, records rooms, hostel accommodation and residence for the Astronomer Royal. The second stage of the scheme comprises the construction of the Meridian Group of buildings to house a series of telescopes, including the Greenwich reversible transit circle, the Bamberg broken transit and the Melbourne reversible transit circle, all of which are to be transferred from Greenwich. In addition, provision will be made in this group for a new instrument—a photographic zenith telescope. Of the buildings in this group, that for the Greenwich instrument will be completed shortly. Contracts have been let for the photographic zenith telescope building and the Bamberg telescope building. The building to house the electrical control gear for the photographic zenith telescope has been completed. The meteorological enclosure, to take rain gauges, thermometers, wind gauges and sunshine recorders, has been completed. Work is due to start shortly on the Equatorial Group, comprising six new observatory domes to house the existing 30-in. and 36-in. reflecting telescopes, the 26-in. and 28-in. refractors, and the astrographic telescope. In addition there will be a building in this group for the Schmidt camera telescope. Designs for buildings for the time department, the Nautical Almanac Office and the Observatory and chronometer workshops are in hand.

THE INTERNATIONAL ASSOCIATION FOR HYDRAULIC RESEARCH.—At the meeting of the International Association for Hydraulic Research, which is to be held at the University of Minnesota, Minneapolis, U.S.A., from August 31 to September 4, under the presidency of Dr. Lorenz G. Straub, the subjects to be discussed at the technical sessions will be density currents; air entrainment by flowing water; waves, beach erosion, and the hydro-mechanics of shore structures; and the basic relationships of sediment transportation by flowing water.

LETTER TO THE EDITOR.

RESEARCH LABORATORY FOR DOCKS AND INLAND WATERWAYS EXECUTIVE.

To the Editor of Engineering.

Sir,—In your description of the new research laboratory of the Docks and Inland Waterways Executive, on page 138, *ante*, you do not, of course, mention the extent of the increase in cost to the user caused by this and other activities of the Executive. In the case of the Widnes and St. Helens Canal, for example, of which I have personal experience, this increase ranges from 12 times to no less than 33 times, and these are no isolated figures.

On the technical side, the tank for testing barge models, for damage caused to canal banks by their wash, is very interesting. It is clear, however, that this particular research has not yet established by how much the extent of the damage, and therefore the cost, rises with increase of speed; otherwise, why is the most extortionate increase in charges applied to houseboats, which are normally static and cause no wash at all? It is also a fact that one of the two entrances to the St. Helens Canal from the River Mersey, that at Fidler's Ferry, has kept open for over 150 years without the aid of models to investigate silting problems; nevertheless, it has become blocked up after only a few months of Docks and Inland Waterways administration. No models are needed to find the reason for this, which was merely neglect of the elementary precaution of regular sluicing out; no doubt, the same explanation would be found to apply to many other cases where "research" is considered essential.

Few could reasonably deny that research is necessary for progress, but in practice it must be kept to the point. Enthusiastic engineers are rarely short of topics for study, which can easily be exploited for propaganda purposes at someone else's expense. But when extravagance becomes so rife that the increase in cost to the user amounts, even in isolated instances, to 33 times, the bounds of all reason have long ago been passed. This laboratory may be intended as a monument to the 5½ years of administration of the Docks and Inland Waterways Executive, which terminate on September 30. Since, however, on the present showing, the result of the developments which you praise in your last paragraph will inevitably be that no one can afford to use the canals, it cannot be regarded as a very creditable one.

Yours faithfully,

R. G. B. Gwyer,
M.A., A.M.I.Mech.E., A.M.I.E.E.

11, Windsor-road,
Clayton Bridge,
Manchester, 10.
August 4, 1953.

"Diesel-Electric Locomotives for New South Wales"—Addendum.—In the article on "Diesel-Electric Locomotives for New South Wales," which appeared on page 139, *ante*, it should have been stated that the traction motors and electric control equipment, as well as the main generators, were manufactured by the British Thomson-Houston Company, Limited, Rugby, who were the main contractors.

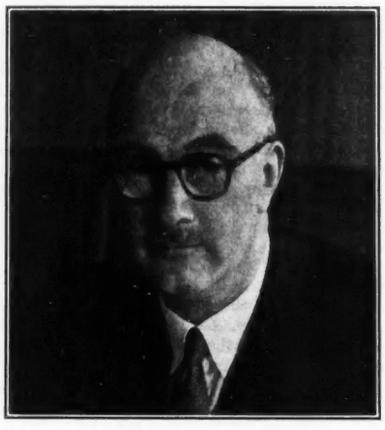
Developments in Germanium diodes.—The range of the point-contact cr̈pâule type germanium diodes manufactured by the General Electric Co., Ltd., Kingsway, London, W.C.2, has recently been revised and extended. Of the existing types GEX 00 has been discontinued and GEX 44/1 has been replaced by GEX 34 for all purposes. GEX 45/1, GEX 55/1 and GEX 66 are unchanged, but GEX 64 is now supplied in groups matched for 5 milli-amperes forward current in the 0·2 to 0·3 voltage range for use in telephony modulators and similar bridge circuits. The new types include the GEX 36, a mixer diode and telephony modulator for use at higher voltage than GEX 64. This is available for a forward current of 5 milli-amperes at 0·675 to 0·875 volts. The four new GEX 54 group of high back voltage diodes operate at 80, 100, 150 and 200 volts, respectively.

OBITUARY.

MAJOR SIR HEW KILNER, M.C.

We record with regret the death of Major Sir Hew Ross Kilner, M.C., on Sunday, August 2, after a long illness. Until his retirement, on account of ill-health, in June this year, Sir Hew was a director of Vickers Limited, deputy chairman of Vickers-Armstrongs Limited, and managing director of Vickers-Armstrongs Limited, Aircraft Division. He was responsible for organising and leading the teams which have produced the Spitfire, Wellington, Viking, Valetta, Varsity, and Attacker aircraft, and are now producing Swifts, Viscounts and Valiants.

Hew Ross Kilner was born in London on September 9, 1892, the son of Colonel C. H. Kilner, D.S.O., R.H.A., and was educated at Cheltenham College and the Royal Military Academy, Woolwich. He was commissioned in the Royal Artillery in 1911,



The Late Sir Hew Kilner, M.C.

and during the first World War he served in France from December, 1914, until January, 1918. In the latter year he was awarded the Military Cross. From 1918 to 1923 he was an instructor in gunnery, and from 1923 to 1927 he served as a Staff Captain at the War Office. In 1929 he passed the final examination of the advanced class at the Military College of Science.

Sir Hew left the army in 1930 to join Vickers-Armstrongs Limited as technical adviser on all forms of armament. The following year he was appointed a special director and general manager of their Southern Engineering Works. He became a director of the company in 1936. In 1940—a fateful year in the production of military aircraft—he transferred to the Aircraft Section as general manager, and in 1944 he became managing director (aviation) of Vickers-Armstrongs Limited. During the second World War he controlled the six main aircraft works of the company. He was appointed a director of the parent company, Vickers Limited, in 1945. The following year he became deputy chairman of Vickers-Armstrongs Limited, retaining his position as managing director (aviation), and in 1952 he became a director and chairman of Messrs. Cooke, Troughton and Simms, Limited, a subsidiary company. He was elected President of the Society of British Aircraft Constructors in 1943, and held that office for two years, after which he was deputy president. In 1947 he was knighted for his services to the country.

MR. J. E. EDGECOMBE.

An earlier generation of electrical engineers, especially those who were engaged in the municipal service, will learn with regret of the death of Mr. J. E. Edgecombe, which occurred at Surbiton on Tuesday, August 4, at the age of 87.

James Edmund Edgecombe was born in London on November 1, 1865, and was educated in both London and Paris. At the age of seventeen he became a pupil of Messrs. Middleton and Company, mechanical and general engineers, of Southwark, and on completion of his time in 1887, he joined the Civil Engineering Department of the Great Western Railway. In 1888, he began his long connection with electrical engineering when he served for a short time on the staff of Messrs. Crompton and Company. A year later he obtained an appointment as engineer with the Kensington and Knightsbridge Electric Lighting Company, and shortly afterwards became second engineer to the Notting Hill Electric Lighting Company, with whom he served until 1893 when he was appointed resident engineer during the construction of the municipal electric power station at Kingston-on-Thames. At that time the installed capacity of the station was 225 kW, an alternating-current supply being given at 2,100 volts and a frequency of 77 cycles. On the completion of this station, Mr. Edgecombe was appointed Borough Electrical Engineer, and during his tenure of the position, which lasted 25 years, a number of extensions took place and the consumption of electricity in the borough considerably developed. In 1918 he left municipal service to become Director of the Electric Lamp Manufacturers Association, a position from which he resigned at the end of 1922. He was subsequently a director of the Stearn Electric Company, Limited.

Mr. Edgecombe was elected an associate member of the Institution of Mechanical Engineers in 1893 and was transferred to the class of member in 1898. His connection with the Institution of Electrical Engineers began in 1892 when he became an associate. He was transferred to the class of member in 1898. He played a leading part in the establishment of the Incorporated Municipal Electrical Association, of which he was honorary secretary in 1904. He served as President in 1906 and again in 1913, and thereafter acted as honorary treasurer until his retirement from the municipal service. He was also a former President of the Diesel Engine Users Association.

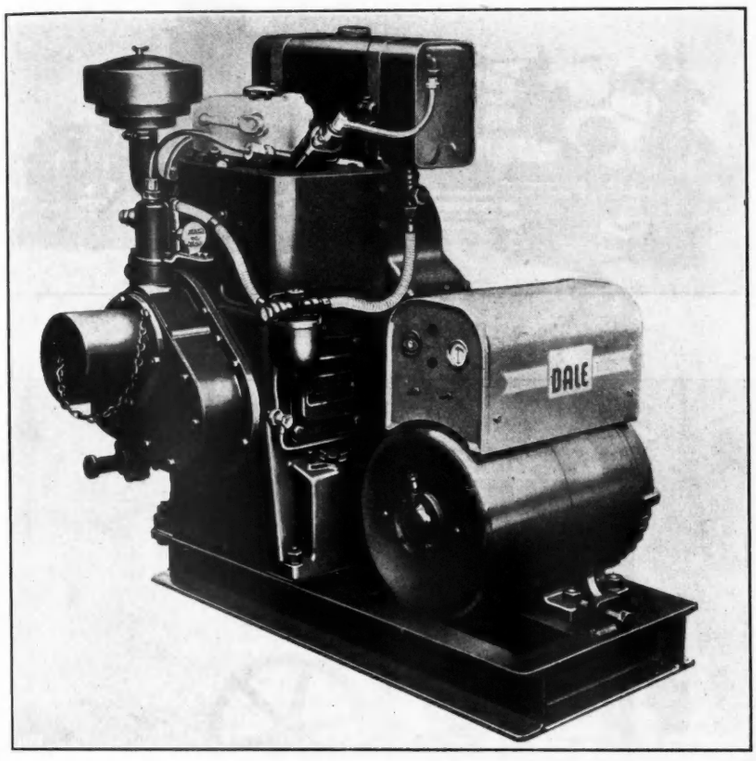
MR. E. F. SPANNER.

His many friends in shipbuilding circles, especially in this country and North America, will regret to learn of the sudden death, on August 3, of Mr. Edward Frank Spanner, formerly a member of the Royal Corps of Naval Constructors, and the inventor of a number of important developments in ship construction. Mr. Spanner, who was born in 1888, was a native of Portsmouth and received his early training in Portsmouth Dockyard as a shipwright apprentice. In 1906, he was awarded a scholarship to the Royal Naval Engineering College at Keyham, and in the following year proceeded to the Royal Naval College, Greenwich. On passing out in 1910—when he was head of the list—he was appointed to Chatham Dockyard and subsequently obtained seagoing experience in H.M.S. Temeraire. During the 1914-18 war, he served at the Admiralty as an assistant constructor, later a constructor, in the department of the Director of Naval Construction; but, on the conclusion of hostilities—thinking, like many others, that the prospects of advancement in that field had largely disappeared with the great reductions that were being effected in the strength of the Navy—he resigned his Admiralty appointment to become assistant general manager with Messrs. R. and H. Green and Silley Weir, Limited, London.

This appointment lasted for five years, on the conclusion of which Mr. Spanner set up in private practice as a consulting naval architect. It was during this period that he began to attract notice as an inventor, notably of the Spanner duct keel and of the "soft" stem, constructed of fashioned plate instead of the then usual forged bar, which is now in general use; and, in the engineering field, of

1,250-WATT DIESEL-ELECTRIC GENERATOR.

DALE ELECTRIC (YORKSHIRE), LTD., FILEY.



the Spanner waste-heat boiler, various types of which have been described from time to time in our columns. Fire prevention in ships, and improved methods of life-saving at sea were also subjects in which he took an active interest; possibly stimulated by the fact that, for nearly 30 years, he was a naval-architect assessor to the Board of Trade and their successors in maritime affairs, the Ministry of Transport. On the outbreak of war in 1939, he returned for a short time to the Admiralty, but was released so that he could attend personally to the war contracts on which his firm, Spanner Boilers, Limited, were engaged. Shortly afterwards, however, he was appointed by the Director of Merchant Shipbuilding to be consultant on the construction of reinforced-concrete small craft.

Mr. Spanner was a member of the Institution of Naval Architects, the Institute of Marine Engineers, the Institution of Engineers and Shipbuilders in Scotland, the North-East Coast Institution of Engineers and Shipbuilders, and, in the United States, the Society of Naval Architects and Marine Engineers, and had contributed papers to all of them. He was also a Fellow of the Society of Consulting Marine Engineers and Ship Surveyors, and a liveryman of the Worshipful Company of Shipwrights. In the years immediately following the 1914-18 war, when the Government were spending large sums of money on the construction of rigid airships, Mr. Spanner vigorously opposed that policy and published several books seeking to ridicule it. The ultimate abandonment of the airship programme was probably due less to public opinion than to economic pressure and the great advances made in heavier-than-air transport, but events certainly justified the strong line that Mr. Spanner took up a quarter of century ago.

MEMORIAL SERVICE TO THE LATE SIR JOHNSTONE WRIGHT.—A memorial service to the late Sir Johnstone Wright will be held at the Queen's Chapel of the Savoy, Savoy-street, London, W.C.2, at 12·30 p.m. on Monday, August 24. It will be conducted by the Rev. Prebendary E. H. Williams-Ashman and a short address will be delivered by Sir John Hacking.

1,250-WATT DIESEL-ELECTRIC GENERATOR.

THE accompanying illustration shows a 1,250-watt remotely-controlled Diesel-electric generator, which is being manufactured by Dale Electric (Yorkshire), Limited, Filey, Yorkshire, for use in mobile workshops, on small farms and for similar applications. It consists of a Petter air-cooled single-cylinder Diesel engine with an output of 2½ h.p. at 1,500 r.p.m. A direct-injection combustion system is used, there being an offset hemispherical bowl in the aluminium-alloy piston, which carries three compression rings, two slotted scraper rings and a fully-floating gudgeon pin. The bore and stroke are both 3 in. The cylinder, which is of cast iron, is provided with deep finning to ensure adequate cooling. The head, which is also finned, carries a box which totally encloses the pressure-lubricated rocker gear. The push rods are housed in the cylinder wall. Both cylinder and head are retained by through bolts from the crankcase, thus minimising distortion and increasing accessibility. The cast-iron crankcase has feet for base mounting and the lower part forms the wet sump.

The connecting rod is of H-section forged steel and carries plain big-end and small-end bearings. The former is copper-lined on steel backing, while the bush of the latter is bronze. The main bearings are steel-backed with white-metal bushes.

Governing is effected by a centrifugal governor, which is totally enclosed in the gear cover. The Bryce fuel pump is mounted on top of the timing gear cover and is actuated by a cam formed on the front of the camshaft gearwheel. The fuel is fed by gravity from a tank of one-gallon capacity, which is mounted on the engine, the spill timing being adjusted by shims under the pump. The bearings and rocker gear are pressure lubricated by a plunger-type pump which is driven by an eccentric on the camshaft. The cylinder and camshaft are splash-lubricated.

The generator is of the drip-proof fan-ventilated type with the rotor running in ball bearings. It is self-exciting and self-regulated, and is provided with starting and charging windings. The insulation is of tropical standard. The switchbox contains the contactors necessary for semi-automatic operation, and is fitted with a charging ammeter, charging circuit fuse and push-buttons. Current for starting is obtained from a 12-volt Exide battery.

TRADE PUBLICATIONS.

Polyester Handbook.—Scott Bader and Co., Ltd., Wollaston, Wellingborough, Northamptonshire, have published a handbook on "Polyester-Reinforced Glass Fibre Plastic." It is divided into eight sections, namely, Chemistry and General Characteristics, Polyester Products, Laminating Applications, Low-Pressure Preform Moulding, Casting Applications, Other Applications, Fillers and Pigments, and Properties.

Copper and Brass Pressings.—The Copper Development Association, Kendals Hall, Radlett, Hertfordshire, have issued a fourth revised impression of their publication No. 26, *Copper and Brass Pressings*, which was first issued in 1937. It deals with pressings and other products cold-formed from strip and sheet, and required in engineering and general industry.

Stainless Steels.—The latest number of the "Enchiridion," or handbook, issued by Firth-Vickers Stainless Steels, Ltd., Staybrite Works, Sheffield, 9, contains illustrated examples of the use of stainless steels for fittings in railway rolling stock and components for automatic signalling equipment, for kitchen and household apparatus, and for large tanks. Views from a new film, "Stainless Steel in Power Production," are also given.

Bakelite Adhesives.—A folder containing sheets of tabulated and other data concerning Bakelite cements, comprising phenol formaldehyde and urea formaldehyde adhesives for wood, metal and plastics, has been sent to us by Bakelite, Ltd., 12-18, Grosvenor-gardens, London, S.W.1. Detailed instructions are given on the preparation of surfaces, mixing procedure and application.

V.D.F. Lathes.—We have received from the Sykes Machine Tool Co., Ltd., Terminal House, London, S.W.1, a brochure describing and illustrating the V.D.F. centre, turret and copying lathes made by the Vereinigte Drehbank-Fabriken Group of Western Germany. These lathes incorporate an electronic-hydraulic system for copying control, and a preselector control for speeds and feeds which, after setting, only then requires push-button operation.

Time Recorder.—Blick Time Recorders Ltd., 96-100, Aldersgate-street, London, E.C.1, have issued an illustrated leaflet describing their recently-introduced Autoclip automatic time recorder for clocking-on. The insertion of the time card into the machine automatically sets in action the recording mechanism which stamps the card and clips it down one edge to ensure the correct location at the following registration.

Electric Sweeper.—An illustrated leaflet issued by Lewin Road Sweepers Ltd., Victoria Works, Hill Top, West Bromwich, gives the specification of their Mark III E battery-electric universal sweeper for industrial use.

Oily-Water Separators.—White's Marine Engineering Co., Ltd., Hebburn-on-Tyne, have issued an illustrated leaflet giving specifications, and describing the operating principles, of their automatic and manually-operated oily-water separators. In the automatic separator, the electrostatic properties of the liquids are used to actuate an electronic relay and motor-driven valves.

Mechanical Handling Equipment.—We have received an illustrated leaflet from J. Collis & Sons, Ltd., Regent-square, Gray's Inn-road, London, W.C.1, describing briefly their range of roller and belt conveyors, elevators, stackers, and trucks. They have recently introduced the VertiVeyor, an elevator which automatically loads and off-loads goods at predetermined points, and the SlatVeyor, for continuously conveying packages at spaced intervals over comparatively steep inclines.

Gear Shaving Machines.—We have received an illustrated leaflet from the Michigan Tool Company, 7171E, McNichols-road, Detroit 12, U.S.A., which gives a detailed description of the six models of gear shaving machines produced in their V series. This group of machines covers gear-cutting capacities from 8 in. diameter to 180 in. diameter and gives a shaving surface-finish from 12 to 20 micro-inches.

Aluminium-Alloy Scaffolding.—The Aluminium Development Association, 33, Grosvenor-street, London, W.1, have sent us a revised leaflet relating to tubular scaffolding and fittings made in aluminium alloys and conforming with the recently issued relevant B.S. specifications.

Pulley-Blocks and Chain Hoists.—We have received from Herbert Morris, Ltd., Loughborough, two illustrated booklets describing a new pattern of pulley-block with improved hooks, and electric chain hoists having working loads from ½ to 5 tons.

THE ENGINEERING HALL, BIRMINGHAM MUSEUM OF SCIENCE AND INDUSTRY.

The Engineering Hall, which is the latest addition to the rooms open to the public at the Museum of Science and Industry, Newhall-street, Birmingham, 3, is also the first to contain heavy exhibits. The opening ceremony was performed by the Lord Mayor of Birmingham, Alderman G. H. W. Griffith, J.P., on June 19. The emphasis in the collection now on view is on the steam engine, but other types of prime mover are exhibited, and there are also items representative of well-known Midland trades, such as the electro-plating industry. Some unique examples of pioneer electrical equipment used in this connection are included. The Engineering Hall, which is illustrated in Fig. 1, on Plate XII, is a spacious building, and the exhibits have been arranged to allow the maximum possible access for inspection. On the whole, fencing has been erected only where it is necessary for public safety, as in the case of certain exhibits which are shown in motion at advertised times, and, in most cases, close inspection of a machine is possible from at least three sides. As will be seen from Fig. 1, some of the exhibits are arranged for all-round access.

There is only one self-propelled engine on exhibition, but it is a particularly fine specimen and represents a class of machine which, though by no means extinct in service, is becoming increasingly rare. It is a 10-ton steam roller, built by Messrs. Aveling and Porter, Limited, in 1892, and is shown in Fig. 2, on Plate XII. It has a single cylinder, 8 in. in diameter by 10 in. stroke, and is fitted with a Morrison's patent scarifier on the offside. It is equipped with a full set of tools, and oil rear and and front lamps, the latter being, appropriately, of Birmingham manufacture. The roller is, in fact, complete in every respect, and would be fully capable of taking up once again the duties for which it was designed. It has spent the whole of its working life in the Midlands, being owned by a Worcestershire public-works contractor, and worked regularly until a year or two ago, when a boiler defect caused it to be withdrawn from service and it was left derelict on a roadside for a time. The owners, Messrs. George Law, Limited, Kidderminster, then made it available for preservation, and it was reconditioned at the works of Messrs. Hunt Brothers (Oldbury), Limited, with the spare-time assistance of two Birmingham engineers, Mr. A. J. Kent and Mr. F. H. Tapper. Re-tubing of the boiler was necessary, and, when this was done, the roller was tested under steam at its original working pressure of 125 lb. per square inch. It was then painted and lined in the traditional manner, and driven under its own steam from Oldbury to the Museum. The nameplate of the original owners is still in position, together with the registration plates of the three counties in which the roller worked. It was the first steam roller to be registered in Worcestershire, the eighth in Warwickshire, and the eleventh in Staffordshire, as the plates indicate.

The oldest exhibit at present in the Engineering Hall is a steam engine (Fig. 3), which, until 1949, was regularly at work at Amblecote, Staffordshire. It is a small non-condensing beam engine, with a cylinder 8 in. in diameter by 2 ft. stroke. The beam is 6 ft. 6 in. long, and has an orthodox Watt-pattern parallel motion at the cylinder end, and a cast-iron cruciform-section connecting rod at the flywheel end. Steam admission and exhaust are controlled by an ordinary D slide valve, operated by eccentric gear and a weighshaft, with hand gear for stopping and starting. A suet lubricator is provided on the top of the valve chest. The speed of the engine was about 25 r.p.m. It has a Watt type of governor, driven from the crankshaft by a flat belt and a pair of cast-iron bevel gears. A small plunger-pole pump is provided on the crank side of the beam trunnions, for boiler feeding.

The early history of the engine is unknown. When it ceased work, it was driving a chaff cutter at a farm belonging to Messrs. John Hall and Company (of Stourbridge), Limited, Amblecote, Staffordshire,

BIRMINGHAM MUSEUM OF SCIENCE AND INDUSTRY.

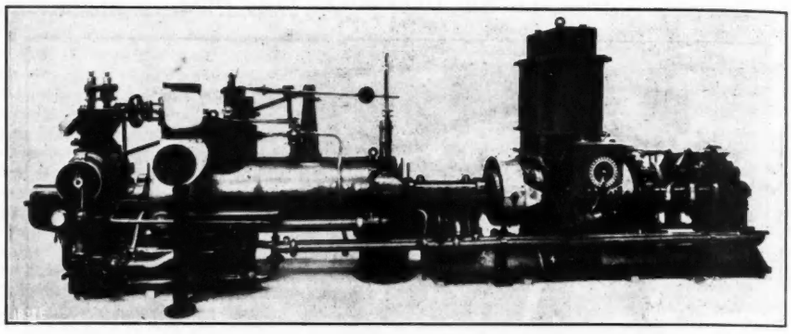


Fig. 5. Parsons Turbo-Generator (1903).

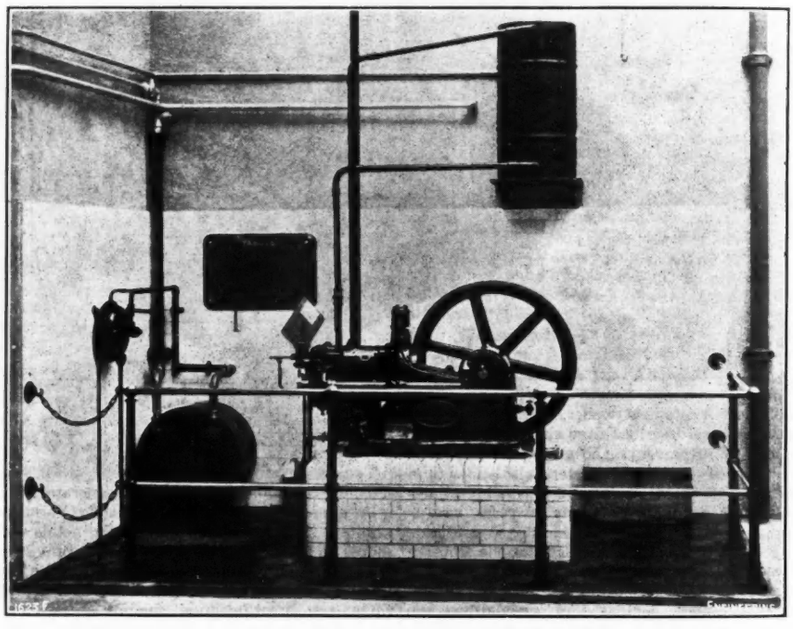


Fig. 6. Tangye Gas Engine (1905).

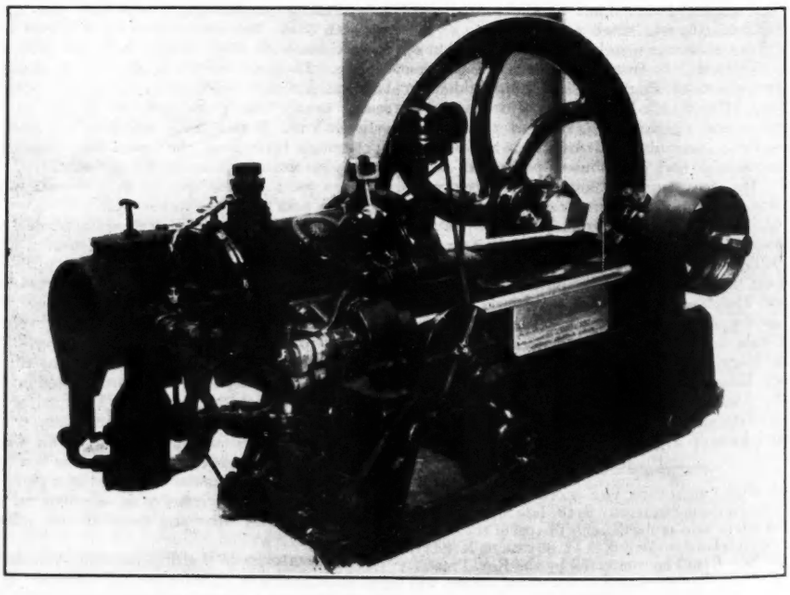


Fig. 7. Hornsby-Akroyd Hot-Bulb Engine (1893).

ENGINEERING HALL AT THE BIRMINGHAM MUSEUM OF SCIENCE AND INDUSTRY.

(*For Description, see Page* 214.)

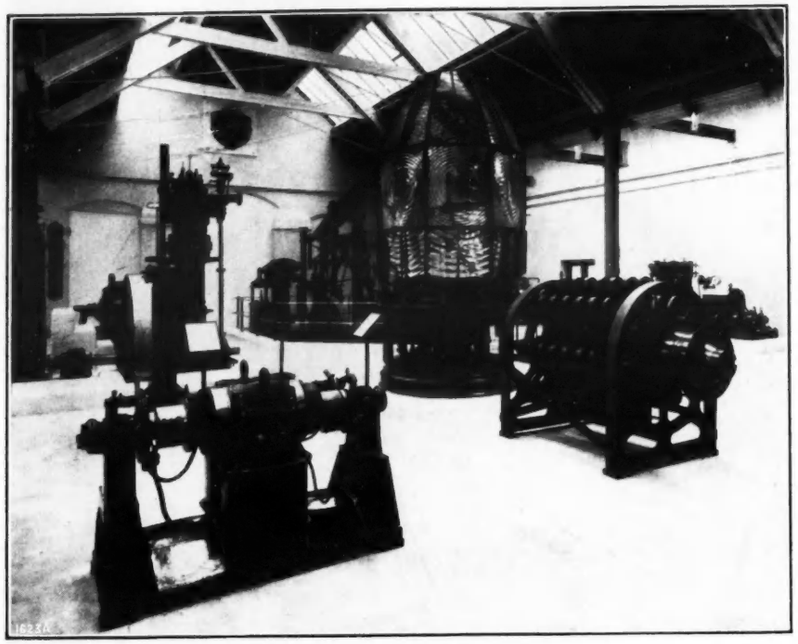


FIG. 1. GENERAL VIEW OF ENGINEERING HALL.

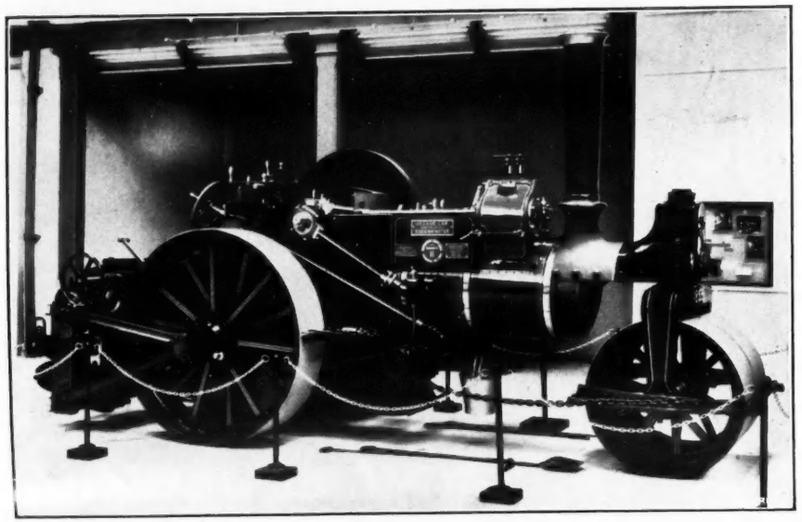


FIG. 2. AVELING AND PORTER STEAM ROLLER (1892).

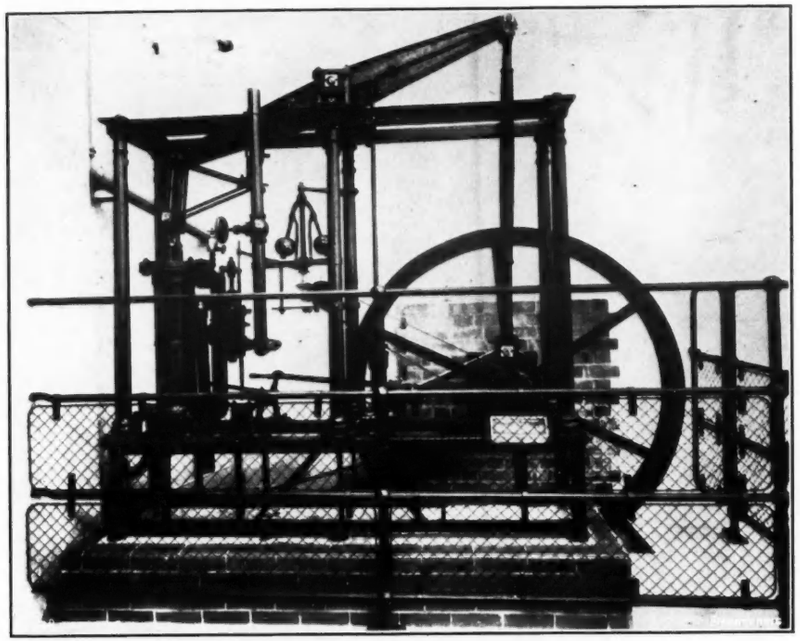


FIG. 3. BEAM ENGINE (C. 1820-30).

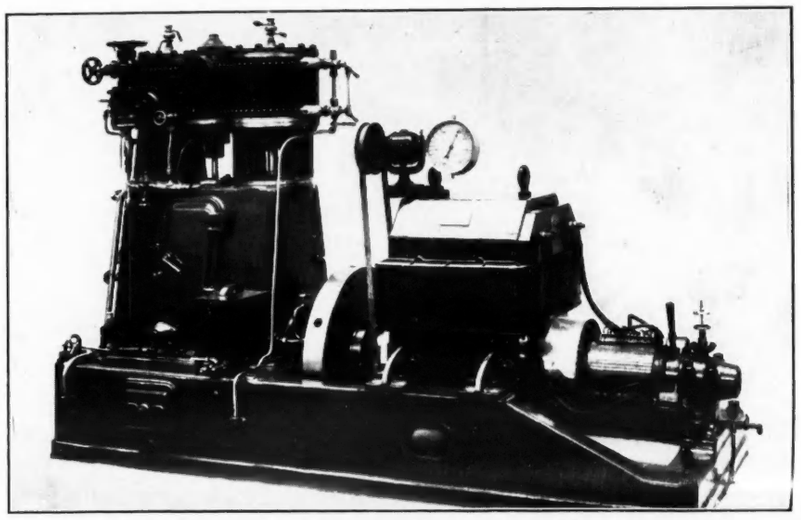


FIG. 4. BELLISS AND MORCOM VERTICAL COMPOUND STEAM ENGINE (1891).

(*To face page* 215.)

BIRMINGHAM MUSEUM OF SCIENCE AND INDUSTRY.

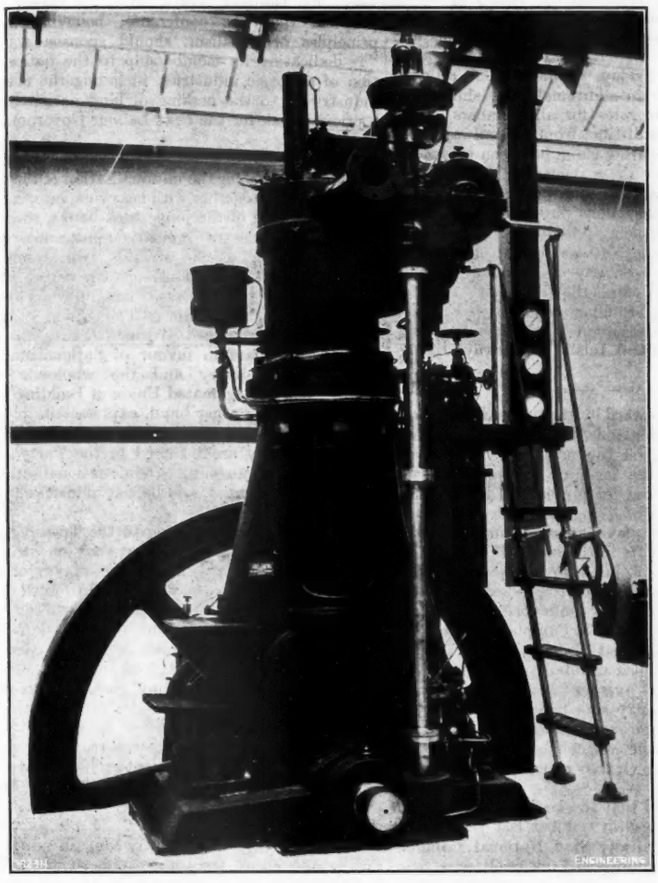


FIG. 8. M.A.N. VERTICAL DIESEL ENGINE (1901).

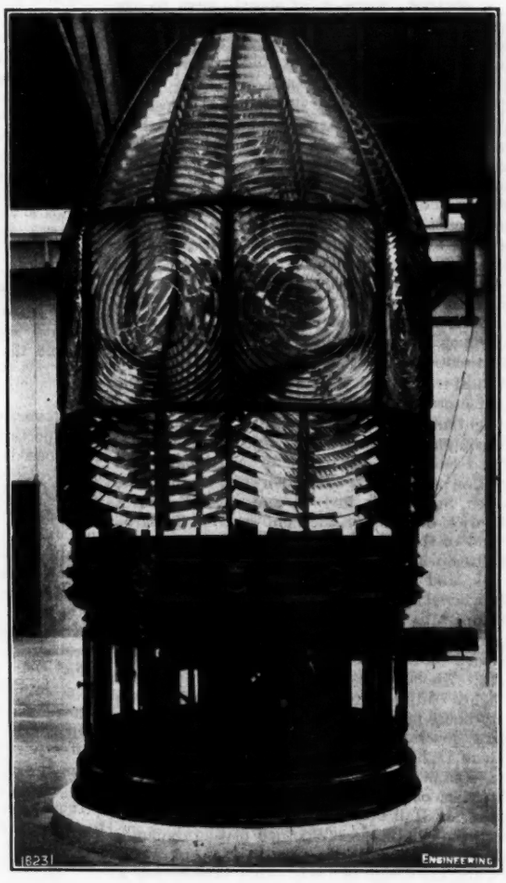


FIG. 9. CHANCE BROTHERS' LIGHTHOUSE APPARATUS (1873).

but according to local tradition it had worked previously at an adjacent firebrick works belonging to the same firm. It was known to have been at the farm for about 50 years. The engine is, in general, of a type common enough in the 1820's; indeed, apart from the fact that the Museum engine is non-condensing, there are only minor differences in construction between it and the one illustrated in Plate XXII in John Farey's *Treatise on the Steam Engine* of 1827. The absence of a condenser is easily accounted for in the South Staffordshire district, where, so long as coal was available at negligible cost, condensing was never in great favour. The Amblecote engine loses nothing because its origin is unknown, being a useful example of a type which was once very common, and was made by countless small foundries and engineering works. It was badly worn when the owners decided to replace it by an electric motor. They presented it to the Birmingham Common Good Trust on condition that it should be housed in a museum. The Trust arranged for the engine to be reconditioned, facilities for this purpose being provided by Messrs. Cadbury Brothers, Limited, in the engineering shop at their works at Bournville. The work of reconditioning was carried out by Mr. T. Arnold Slack, a retired Cadbury employee. A concealed electric motor enables the engine to be shown in motion, and it is run at various times, according to an advertised schedule.

The Engineering Hall has another beam-engine exhibit which is of a very curious design, consisting of two engines coupled together. Coupling two engines is, of course, in no way unique, but the method of doing so in this case is an example of millwrights' improvisation, possibly brought about by the availability of some cheap secondhand parts. The engines came from a non-ferrous metal rolling mill at Wychall, King's Norton, where they were at work until the end of the 1939-45 war. The mill was originally driven by a water wheel, and, at some unknown date, a simple non-condensing beam engine was added to provide extra power. This engine, which has a cylinder 18 in. in diameter by 5 ft. stroke, possesses no unusual features. It is of the A-frame pattern, as made by numerous manufacturers from the early years of the Nineteenth Century onwards. Later, the power available being insufficient for the work then being done, another engine, 36 in. bore by 2 ft. 6 in. stroke, was coupled to the first one by means of 4 : 1 cast-iron gearing, and compounded with it. The second engine was also provided with a condenser and air pump. To add a second cylinder to an existing engine was a common arrangement when extra power was needed, but to do so with the second engine running at four times the speed of the first was decidedly unusual. The two engines were not always run together. At times, the power of the first engine alone was sufficient, and it was then run with its exhaust to atmosphere, the second engine being disconnected. To take the second engine out of commission was rather a complicated procedure, since there was neither a clutch between the engines nor stop valves in the steam pipes. A certain amount of dismantling was necessary, therefore, to enable the steam pipes to be blanked off, and to disconnect the smaller engine. The Wychall engines are partly visible in the right background of Fig. 1.

Illustrating the ultimate development of the reciprocating steam engine as a high-speed machine, there is a fine example of a Belliss and Morcom enclosed vertical compound engine, shown in Fig. 4 on Plate XII. It has A. C. Pain's patented system of forced lubrication, and was built in 1891, the year following the grant of the patent. The engine is coupled to a direct-current dynamo, which it drove at 625 r.p.m., and which had an output of 325 amperes at 107 volts. It was formerly installed at Kirkheaton, near Huddersfield, and was brought back to the works of the makers, Belliss and Morcom, Limited, Ledsam-street, Birmingham, in 1952, and rebuilt by the company's apprentices before being installed in the Museum.

The next development of steam as a prime mover is illustrated by a Parsons turbo-generator of 1903 (Fig. 5, page 214). It is an axial-flow turbine coupled to a direct-current generator of 20 kW capacity at 230 volts, which it drove at 3,600 r.p.m. The turbo-generator was installed at a salt works at Lymm, Cheshire, where it worked until 1950, when the salt works closed down. The set was then removed to the Birmingham Museum for preservation.

Another type of prime mover which was formerly very common is the single-cylinder horizontal gas-engine. Numerous examples of this type of engine can still be found at work, but it is becoming rare. The Museum's specimen (Fig. 6, opposite) is a 2¾ brake horse-power engine built by Tangyes, Limited, Cornwall Works, Smethwick, in 1905. It has been installed in complete working order, and is shown running on gas at regular intervals. The engine is fitted with the well-known "hit-and-miss" governor, which, as it is running light, can be seen in operation to full advantage. The completeness of the installation is indicated by the fact that there is a full set of tools, and even a contemporary instruction booklet.

There are several examples of oil engine in the Engineering Hall, and two are of special interest. The first is a Hornsby-Akroyd single-cylinder hot-bulb engine, built in 1893 by R. Hornsby and Sons, Limited, Grantham, Lincolnshire, and is illustrated in Fig. 7, opposite. The engine, which developed 3·56 brake horse-power at 225 r.p.m.,

FIG. 4. BELLISS AND MORCOM VERTICAL COMPOUND STEAM ENGINE (1891).

FIG. 2. AVELING AND PORTER STEAM ROLLER (1892).

is complete in all respects, having the original hot-bulb heating lamp, with a hand-operated fan. The cylinder is 7 in. in diameter by 12 in. stroke. As a contrast, there is exhibited, next to the Hornsby-Akroyd engine, a modern Ruston and Hornsby single-cylinder vertical oil engine of the "square" type, 4 in. bore and stroke, which develops 5 h.p. at 1,000 r.p.m.

The second of the early oil engines is a vertical single-cylinder M.A.N. engine, one of two which were formerly at the pumping station of the Belper Rural District Council, near Matlock, Derbyshire; it is shown in Fig. 8, on page 215. The makers were the Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nürnberg, and the engine was built in 1901. It has a bore of 10 in. and a stroke of 20 in. and developed 35 brake horse-power at 400 r.p.m. It is complete with a Reavell air compressor and two air bottles for starting, and, though it is not shown in operation, is in full working order, and may be arranged for demonstration in motion at a later date.

A local trade which is unique in this country, the manufacture of optical and mechanical apparatus for lighthouses, is represented by the complete light equipment formerly at Longstones lighthouse, Farne Islands, off the coast of Northumberland (Fig. 9, on page 215). It was built by Chance Brothers, Limited, Smethwick, in 1873, and originally had a multi-wick oil lamp as the light source. Towards the end of the Nineteenth Century, the apparatus was fitted with incandescent mantles operating on oil gas, and in this condition it remained until 1952, when it was replaced with modern equipment. The apparatus is arranged to be shown in motion, the clockwork mechanism being driven by a small concealed electric motor, in place of the original weight. An incandescent electric bulb provides the light. Adjacent to this exhibit is another item of lighthouse interest. It is a Holmes's alternating-current generator which was in use at South Foreland Lighthouse, Kent, from 1867 to 1921. It can be seen in front of the Longstones light in Fig. 1.

There are other items of electrical interest in the Engineering Hall besides those already mentioned. Among the exhibits is a Woolrich plating dynamo, made by Prime of Birmingham in 1851, to Woolrich's original design of 1842. This machine has a cast-iron frame, and provides a contrast with the first Woolrich dynamo, which was built in 1844, and has a wooden frame. This dynamo is also the property of the Museum, but is not on view in the Engineering Hall, being displayed elsewhere on the premises. There is also a Wylde separately-excited dynamo, made about 1866 for electro-plating, and an Edison Z-type dynamo of 1881. Machines for the conversion of one type of electric current to another are represented by a rotary converter built by Thomas Parker, Limited—the forerunners of the Electric Construction Company, Limited, Bushbury, Wolverhampton—in 1898. It operated in a Birmingham theatre, taking direct current at 440 volts, and converting it to 75 volts for arc lamps. It was in regular use until 1950, when it became obsolete as a result of the supply being changed to alternating current. The Parker rotary converter is visible in the foreground of Fig. 1.

Research Workshop for the Coal-Mining Industry.—An announcement by the National Coal Board, issued on August 6, stated that a research workshop is to be erected shortly on the site of a disused coal mine at Bretby, South Derbyshire. The new workshop, which will be the first of its kind in Britain, will carry out engineering research which cannot be undertaken at the Board's research laboratory. The urgent need for the workshop was referred to in the Board's annual report.

Rolls-Royce "Avon" Engine.—It is announced that the Avon RA 14 axial-flow jet engine, designed and constructed by Rolls-Royce Ltd., Derby, develops a thrust of 9,500 lb. without the use of reheat. This figure is based on type tests passed in April, since when many more hours of development flying have been completed. The first Avon RA 14 engine was run for the first time some 20 months ago; it is now in production and delivery has already commenced. The manufacturers state that the Avon RA 14 develops the greatest thrust per square foot of frontal area yet achieved.

LABOUR NOTES.

Wage increases demanded by railway operating staffs were considered at a meeting between the leaders of the three principal railway unions and representatives of the Railway Executive at a joint meeting last Friday. Some 600,000 railwaymen are asking for an additional three shillings in the pound on basic rates for all members of the operating grades, as distinct from the railway shopmen for whom a separate claim has been presented. It is estimated that these demands, if granted in full, would cost the Executive nearly 40 million pounds a year. The unions putting forward these demands, which are being presented in the form of a joint claim, are the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, and the Transport Salaried Staffs' Association. Similar demands have been presented by the three unions to the Hotels Executive and the Docks and Inland Waterways Executive.

Arguments put forward by the unions last Friday, in support of their demands, are understood to have been based mainly on the need for bringing the men's pay up to the level of that obtaining in industry generally and for providing compensation for rises in the cost of living. In this connection, the unions' leaders have stressed not only the advance of three points in the index of retail prices since November, 1952, but also the changes which have occurred in the level of the index for several years past. Speaking at a conference at Paington, Devon, in mid-July, Mr. J. S. Campbell, the general secretary of the National Union of Railwaymen, stated that, if the index of retail prices were taken as a standard, the average wage of employees throughout the country was five points below its proper level. In the case of the railway operating staffs, however, their wages lagged 16·1 points below the level at which they should stand.

It may be recalled that the last increase granted to the railwaymen was in October last year, when an award by the Railway Staff National Tribunal gave adult men an additional 7*s.* a week, with proportional increases for women and juveniles. That award was made after the Railway Executive had rejected a claim for a general increase of 10 per cent. After last Friday's meeting, Mr. W. P. Allen, the member of the Executive dealing with labour problems, stated that the unions' case would be carefully considered and that their reply would be given to the men's leaders at an early date. This is likely to emphasise the lack of progress which has followed the promise of the unions, made after the award last October, that the men would co-operate with the Executive in any measures introduced for increasing the efficiency of the railway service.

Although nearly 400 resolutions are to be discussed at the forthcoming annual conference of the Labour Party, only 15 of them have been placed on the agenda by affiliated trade unions. The great mass of these resolutions reveal what the members of the various constituency parties consider to be of most importance. They cover, naturally, a great variety of subjects and not all are of equal importance. There will, of course, be a good deal of pruning by the relevant committee, and, inevitably, many varied motions are likely to be grouped together into composite resolutions. Only in this way will it be possible to simplify discussions and concentrate attention on the major issue before the conference, namely, the statement of policy put forward by the Party's national executive committee under the title *Challenge to Britain*.

One of the trade unions which have sent in motions for consideration at the conference is the Amalgamated Engineering Union, and, commenting on this in the August issue of the union's journal, Mr. Ben Gardner, O.B.E., the union's general secretary, states that the main issue at the meeting is obviously going to be the question of extending the Party's nationalisation programme. It is worthy of note, in this connection, that there are 30 resolutions under that heading on the agenda and that only two of them have been framed by trade unions. The remaining 28 have been put forward by constituency parties. The resolutions vary, Mr. Gardner writes, from the rather naïve proposal that the conference, believing in the principles of socialism, should sponsor a policy "re-dedicating its membership to the nationalisation of all basic industries, including the chemical industries," to the making of land nationalisation a priority task for the next Labour Government.

Other resolutions respecting State ownership, include demands for the nationalisation of the entire arms industry, together with heavy engineering, and for the bringing of the joint stock banks, as well as the entire fabric of industrial insurance, under public control. Each of the two resolutions sponsored by trade unions, on this aspect of the Labour Party's policy, ask for additions to its nationalisation programme. The Union of Shop, Distributive and Allied Workers desires the conference to declare in favour of nationalising the slaughtering industry and the wholesale meat trade. The Amalgamated Union of Building Trade Workers, on the other hand, expresses its pleasure that proposals for the public ownership of the cement industry are included in the Party's programme, but desires to extend nationalisation to the brick, stone, sand, and ballast industries.

Dock employees belonging to the Transport and General Workers' Union, who went on strike at Great Yarmouth on August 6, in support of their demands for increased pay, returned to work on the following day. It was announced subsequently that an increase of 7 per cent. in the basic rate for unloading cargoes of timber had been conceded. This decision followed a long meeting between employers' representatives and local officials of the union.

The total number of persons registered at the Ministry of Labour employment exchanges as unemployed declined from 430,000 to 282,000 during the first six months of this year. By July 13 last, the number had declined to 272,700, of whom 15,300 were only temporarily out of work. A further 126,000 of the total had been unemployed for not more than eight weeks. The total was 25,100 fewer than on June 15 last. Unemployment on July 13 represented 1·3 per cent. of the estimated total number of employees, compared with 1·4 per cent. on June 15, and 1·9 per cent. on July 12, 1952.

There was an increase of 33,000 persons in the total working population of Great Britain during the six months ended June 30, 1953. On that date, the number of persons, aged 15 and over, who were working for pay or gain in Great Britain, or who had registered themselves as available for such work, numbered 23,325,000, of whom 15,862,000 were men and boys, and 7,463,000 were women and girls. Of that total, 22,190,000 persons were engaged in civil employment (industry, commerce and services of all kinds), an increase of 171,000 since December 31, 1952. The size of the armed Forces declined by 7,000 to 865,000 at the end of June, of whom 841,000 were men and 24,000 were women. The remainder of the working population on June 30, 270,000 persons, were those seeking work.

Statistics issued by the Ministry of Labour last Saturday show that, during the six months ended June 30, 1953, there was an increase of 35,000 in the number of persons employed in the basic industries, which comprise mining, quarrying, agriculture, fishing, gas, electricity, water, transport and communications. The total number employed in that way at the end of the period was 4,067,000. In the manufacturing group of industries, including chemicals, metals, engineering, clothing, food, drink and tobacco, there was an increase of 40,000 in the number of persons employed during the six months, the total on June 30 last being 8,723,000. There was, however, a steady decline during this period in employment in the engineering, metal-goods, and precision-instrument industries. This decline was offset by recoveries in the textile and clothing industries, but here, also, numbers fell in June.

MOTOR LINER "SAMOA."

A/S BURMEISTER & WAIN'S MASKIN-OG SKIBSBYGGERI, COPENHAGEN.

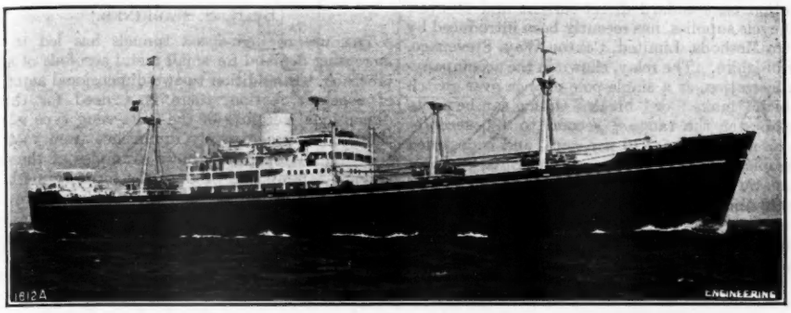


FIG. 1. THE VESSEL AT SEA.

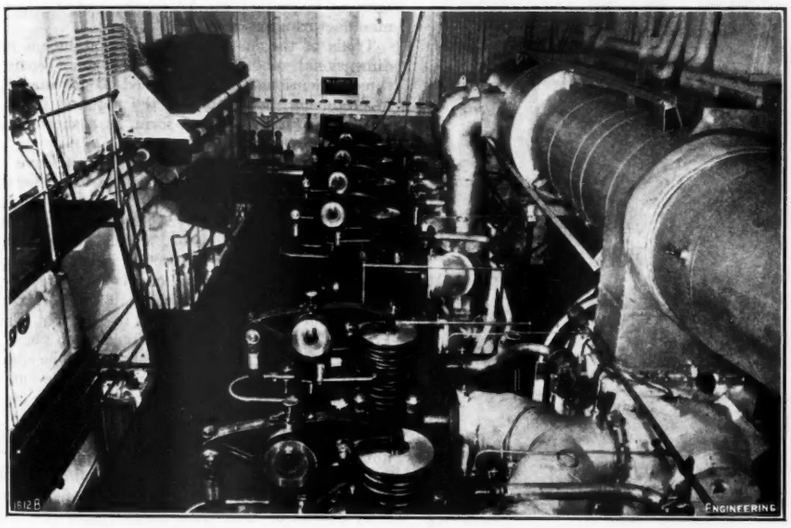


FIG. 2. TOP OF ENGINE, SHOWING EXHAUST CONNECTIONS TO TURBINE.

THE MOTOR CARGO-LINER "SAMOA."

MESSRS. BURMEISTER AND WAIN have delivered recently from their shipyard at Copenhagen the passenger and cargo motorship Samoa, which they have built and engined to the order of the East Asiatic Company, Limited, of Copenhagen. The vessel, which is illustrated in Fig. 1, herewith, has been built under the survey of Lloyd's Register of Shipping and to their highest class, and has also been accorded the society's refrigerating-machinery certificate. The main particulars of the vessel are as follows: length between perpendiculars, 138·99 m. (456 ft.); beam, 19·05 m. (62 ft. 5 in.); depth to upper deck, 11·66 m. (38 ft. 3 in.); depth to second deck, 9·07 m. (29 ft. 8 in.); and draught, about 8·3 m. (27 ft. 3 in.). The deadweight carrying capacity is about 10,100 tons, and the speed on loaded trials, 16·8 knots.

The Samoa is a single-screw motorship with two complete decks, a raked stem, and a cruiser stern. The engine room is amidships, with three holds forward and two holds aft. The aftermost section of No. 3 hold and the foremost section of No. 4 hold are occupied by four deep tanks for the transport of vegetable oil. In No. 3 hold, on the 'tween deck, are two refrigerated spaces with a total capacity of 233 cub. m. (8,128 cub. ft.). Messrs. Thomas Ths. Sabroe and Company have supplied the refrigerating plant for the hold and the refrigerated store-room.

The vessel is rigged with two "bipod" masts, one bipod derrick post, and two ordinary derrick posts in front of the bridge. The hatchways are served by twelve 5-ton derricks, and there are also two heavy derricks of 60 tons and 20 tons lifting capacity, respectively. On the after end of the boat deck there are two 3-ton deck cranes, serving No. 4 hatch. All the winches are electrically driven and, with the steering gear, anchor winch and the two deck cranes, have been supplied by Thomas B. Thrige. The ship is provided with three 7·3 m. (24 ft.) aluminium lifeboats and one 7·6 m. (25 ft.) aluminium motorboat, all of which were supplied by the Nauta-Boat Company. The boats are carried on Schat gravity davits. There are also two wood-built dinghies.

Amidship on the promenade deck there is accommodation for 12 passengers in four double-berth and four single-berth cabins, each with its own bathroom. In the cabins, the bulkheads are of Warerite, which is also used extensively in the officers' and the crews' quarters, and the furniture and doors are of treated mahogany. On the same deck there is a smoking room forward, and a dining room aft, the former furnished in walnut and the latter in teak. The quarters for the captain and the pilot are on the bridge, the captain's quarters comprising a separate bedroom, bath, and toilet. Accommodation for the chief engineer, the other engineers, and the deck officers is on the boat deck. The chief engineer, like the captain, has a separate bedroom, bath and toilet. Also on this deck are the hospital, wireless room, and the officers' wardroom. The amidship house on the upper deck accommodates the assistants, cadets, and galley personnel, together with their messrooms and those for the officers and crew.

The crew's sleeping accommodation is in the poop, all but two of them having single-berth cabins; and their recreation room also is on the poop deck. The saloons and cabins are heated by steam and electric heaters. The galley is in the after part of the 'midship deckhouse, and is equipped with an electric range and a Vesta baking-oven. There is an electric lift between the galley and the dining-room pantry above. Underneath the galley is a store room divided into a section for dry stores and another for refrigerated victuals. The deckhouse between hatches No. 4 and 5 contains the mechanised laundry, with machines supplied by Georg E. Mathiasen, together with a workshop, smithy, and a mess for dock workers. The navigating instruments include a wireless direction-finder, radar, a gyro compass with automatic pilot, an echo sounder, electric log, etc. The fire-extinguishing installations in holds and engine room comprise a CO_2 plant with smoke detector, and an Ellehammer foam extinguishing system.

The main propelling machinery consists of a Burmeister and Wain single-acting poppet-valve seven-cylinder two-stroke engine of the crosshead type, fitted with a turbo-charger. The cylinders have a diameter of 740 mm. and a stroke of 1,600 mm. An illustration of the engine room is reproduced in Fig. 2. In normal continuous service, the engine develops 8,750 brake horse-power, corresponding to 9,870 indicated horse-power, at 115 r.p.m. and an indicated mean pressure of 8 kg. per square centimetre (114 lb. per square inch). This is 35 per cent. more than the brake horse-power developed by a non-turbocharged engine with the same main dimensions, at the same revolutions.

Compared with an installation with a nine-cylinder engine without turbocharge, developing 8,300 brake horse-power at 115 r.p.m., there is a saving of 30 per cent. in weight and 20 per cent. in the length of the main engine, which corresponds to a reduction in the length of the engine room by three frame spaces. There is also a reduction in the size of the starting-air receivers, the compressors, the fresh-water and salt-water cooling pumps, and the lubricating-oil pumps; and, of course, a reduction in the consumption, corresponding to the smaller number of cylinders.

The scavenging air is supplied by two centrifugal blowers, each coupled directly to a turbine, driven by the exhaust gases from the engine. From the turbines the gas is led to a waste-heat boiler which also serves as a silencer, and which produces the same quantity of steam as would be obtained from an engine of the same output without a turbocharger. Air coolers are fitted between the blowers and the scavenging-air receiver, reducing the temperature of the air to about 10 deg. C. above that of the cooling water. To guard against the unlikely event of both turbochargers breaking down, a small electrically-driven emergency blower is provided, capable of keeping the vessel under way at 60 per cent. of the normal speed. Apart from the fitting of turbochargers in place of the chain-driven scavenging-air blower, the engine is of the normal design. It may be added that, up to the middle of June, Messrs. Burmeister and Wain and their licensees have completed three such installations, and have on order 58 more turbocharged plants, with a total of 443 cylinders.

The auxiliary machinery includes three single-acting four-cylinder four-stroke trunk-piston Diesel engines, directly coupled to direct-current generators, each with an output of 120 kW at 220 volts. The cylinder diameters are 245 mm., the stroke 400 mm., and the output 180 b.h.p. at 400 r.p.m. Both the main and the auxiliary engines can operate on either Diesel oil or boiler oil. Two self-cleaning fuel-oil purifiers and fuel-oil heaters are installed in the engine room, and the tanks for boiler oil are provided with heating coils.

COURSES IN HIGHER TECHNOLOGY.—The London, and Home Counties Regional Advisory Council for Higher Technological Education have issued Part I (Autumn, 1953) of their *Bulletin of Special Courses in Higher Technology*, 1953-54. Copies of Part I may be obtained from the secretary of the Regional Advisory Council, Tavistock House South, Tavistock-square London, W.C.1, price 1*s.* 6*d.* post free. A subscription of 2*s.* 6*d.* covers one copy of Part I and also a copy of Part II (Spring and Summer, 1954), which will be published in December.

MEDIUM-RANGE AIR-LINER PROJECT.

Some preliminary details have been released on a projected design for a new commercial transport aircraft, to be known as the Accountant, by the designers, Aviation Traders (Engineering), Limited, Stansted Airport, Stansted, Essex. The Accountant, which will operate over a practical stage length of 920 miles with full fuel reserves, is designed to be suitable both for passenger and freight carriage, with an unobstructed cabin floor, level at lorry floor height, and a nose section which swings to one side to give free access for loading. Two standard 14-h.p. cars, or boxed equipment up to 4 ft. 3 in. by 4 ft. 6 in. by 26 ft., can be accommodated in the cabin. The seating capacity is for 22 to 33 passengers in rearward-facing seats; a dividing partition can be fitted to enable freight and passengers to be carried on the same flight.

An all-metal low-wing monoplane with a tricycle undercarriage, the Accountant will be powered by two Rolls-Royce Dart engines and is designed to meet the take-off performance requirements laid down in the current British Civil Airworthiness Requirements. Large emergency exits are to be provided at the rear of the cabin in accordance with the recommendations of the Civil Aeronautics Administration (U.S.A.) and the Air Registration Board. An unorthodox method of longitudinal panel construction is used for the fuselage and tail unit which, it is claimed, reduces manufacturing costs and structure weight. A prototype fuselage is in course of construction.

The estimated all-up weight is 21,000 lb. and the disposable load is 9,000 lb. The wing span is 64 ft., the overall length 55 ft. 6 in., and the height 20 ft. The cabin is 28 ft. 8 in. long and 6 ft. 3 in. high and provides a width of 7 ft. 5 in. for seat accommodation. The total cabin volume, including toilet space, is 1,250 cub. ft. Over a stage length of 920 statute miles, at a cruising speed of 300 m.p.h. at 30,000 ft., the direct operating costs, calculated in accordance with the Society of British Aircraft Constructors' standard method, are estimated at 1*d*. per passenger mile, or 21*d*. per aircraft statute mile. The distance required to take off and clear a 50-ft. obstacle, in standard atmospheric conditions, is estimated to be 2,040 ft., the maximum continuous rate of climb 2,500 ft. per minute at sea level, and 500 ft. per minute at 30,000 ft. The estimated time to climb to 30,000 ft. is 24 minutes, during which a distance of 86 statute miles will have been covered. The maximum continuous true air speed at 25,000 ft. is 316 m.p.h.

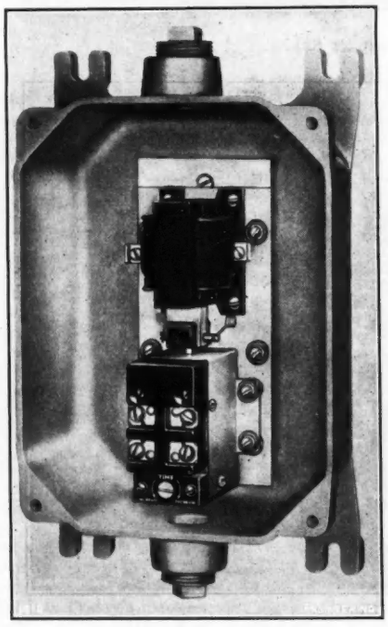
The Institution of Production Engineers.—Medal awards of the Institution of Production Engineers for the session 1951-52 will be distributed at the annual dinner of the Institution, to be held in the Guildhall, London, on October 9. The Institution Medal for the best paper by a member will be presented to Mr. A. Cameron, author of "Increased Productivity by Workshop Practice." The Institution Medal for the best paper presented by a non-member will be handed to Dr. J. D. Jevons, author of "How the Production Engineer can be helped by the Metallurgist." The Hutchinson Memorial Award for graduates will be presented to Mr. J. Poulter, author of "Industrial Application of Porous Ceramics."

Factory Equipment Exhibition.—The Second National Factory Equipment Exhibition will be held at the two halls of the Royal Horticultural Society, in Vincent-square and Greycoat-street, Westminster, London, S.W.1, from Monday, March 22, to Friday, March 26, 1954. The exhibition is designed to provide an opportunity for the display of equipment used in the maintenance and layout of works and factories; the manufacturing, lifting, transporting, storing, and packing of merchandise of various kinds; employees' welfare and safety schemes; and record-keeping systems. The sponsors of the exhibition are the two monthly magazines, *The Factory Manager* and *Factory Equipment News*, both published by Production Publications (London), Ltd., 117, Kingsway, London, W.C.2. Communications should be sent to the organiser, Mr. J. E. Holdsworth, at that address; or to Mr. M. Higgins, 8, Searle-street, London, W.C.2.

PNEUMATIC TIME-DELAY RELAY.

A new pneumatic time-delay relay, suitable for operation on standard direct-current and 50-cycle or 60-cycle supplies, has recently been introduced by Electro Methods, Limited, Caxton Way, Stevenage, Hertfordshire. The relay, shown in the accompanying illustration, is a single-pole change-over switch in which "make" or "break" timing can be set to operate over the range $\frac{1}{2}$ second to 180 seconds, with an accuracy of ± 10 per cent., and is designed for tropical operation. It consists of a compact pneumatic system actuated by a spring-loaded solenoid and enclosed in a cast-aluminium housing.

The pneumatic system comprises a spring-loaded synthetic-rubber bellows and an adjustable air valve controlling the rate of expansion of the bellows.



An air filter protects the system against the entry of dust. The solenoid is a rigidly constructed assembly of low-loss silicon-iron laminations, with a fully-impregnated coil and a shaded-pole plunger. When the solenoid is de-energised, the plunger is withdrawn from the coil by the solenoid spring, and compresses the bellows. When the solenoid is energised, the plunger is pulled back into the coil, allowing the bellows to expand under its own spring tension, the rate of expansion being regulated by the setting of the air valve. As the bellows attains its full expansion, a snap-action double-break and make switch is automatically engaged and held so long as the solenoid is energised. When the solenoid is de-energised, the contacts snap open and the solenoid plunger again withdraws to compress the bellows.

Air Service to Africa.—Subject to the fulfilment of certain conditions, the Ministry of Civil Aviation have approved the operation, for a trial period, of a new "coach"-class air service by the Central African Airways Corporation, on the route Salisbury, Lusaka, N'dola, Nairobi, Malta and London.

Liége International Fair, 1954.—The sixth Liége International Fair will be held at Liége from Saturday, April 24, to Sunday, May 9, 1954, inclusive. The arrangements will include the holding of specialised exhibitions dealing with mining, metallurgy, mechanical engineering, and electrical engineering. A number of technical sessions will be held in connection with these specialised exhibitions, and an international conference on "The Complete Gasification of Coal" is being arranged by the Institut National de l'Industrie Charbonnière. Programmes and other information may be obtained from the manager, Foire Internationale de Liége, 17, Boulevard d'Avroy, Liége, Belgium.

THE MANUFACTURE AND INSPECTION OF AEROFOIL MODELS.*

By R. S. Marriner.

The use of high-speed tunnels has led to an increasing demand for small metal aerofoils of high precision. In addition to two-dimensional aerofoils of constant section, there is a need for three-dimensional aerofoils of the delta-wing type where the section progressively diminishes from root to tip. Fig. 4, opposite, shows examples of the two types. Attempts to produce the form by methods which relied mainly on hand work failed to provide the precision required, final inspection revealing errors of form which made the models unacceptable to the limits imposed. It was therefore decided to try a machining process which would generate the form required by cutting a large number of enveloping tangential planes. Apart from its sound geometrical principle, this technique has the considerable advantage that a simple but adequate form of inspection can be carried out during the manufacturing process.

Trials of the method, firstly to produce a two-dimensional model and then the more complex three-dimensional model, proved to be successful in producing models within the required limits of $\pm 0{\cdot}001$ in. from nominal form, in a shorter time than by previous methods.

The typical models shown in Fig. 4 have the common feature that their surfaces are generated by straight lines. The surface of the two-dimensional one is generated by a straight line, perpendicular to the root plane, which sweeps out a previously-defined aerofoil section in the root plane, and the three-dimensional one is generated by a straight line which passes through the vertex and sweeps out an aerofoil section in the root plane. Provided that the aerofoil section has no points of inflection, each straight-line generator of the surface lies in a plane which is tangential to the surface and which meets the surface only along the generating line.

The principle of the method is to cut a large number of enveloping tangential planes in an oversized blank, and, by a minimum of hand-finishing, to remove the slight excess metal at the intersections of consecutive planes, thus ensuring a smooth blending of the tangential planes. Fig. 5 shows diagrammatically a section through a model with a number of tangential planes. In practice, it is found that about 20 tangential planes per side are sufficient to produce a model, leaving only a few ten-thousandths of an inch excess metal at the successive intersections. The practical problem of cutting the enveloping tangential planes can be resolved into (i) providing a means of cutting a plane parallel to, and at any required distance from, a datum surface, and (ii) presenting the blank to the cutter in such an aspect that any specified tangential plane is parallel to the datum surface and at a known distance from it.

Machines Used.

The machine tools available for machining planes parallel to their work-tables are surface grinders, universal milling machines, and jig millers. Of these, the surface grinders, though providing the greatest accuracy, have the disadvantage of relatively small headroom between the grinding wheel and the work-table, so that their use in the manufacture of models demands special fixtures to satisfy the second consideration. To avoid the delays which the manufacture of such fixtures would require, milling methods were used in the initial trials.

To produce two-dimensional models, the blank is mounted between the head and tailstock centres of an optical dividing head which is mounted on the work-table of a universal milling machine, as shown in the diagram reproduced in Fig. 1. The previously-calculated rotation of the blank required to bring any specified tangential plane parallel to the work-table is set by means of the dividing head.

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* Communication from the National Physical Laboratory. Abridged.

MANUFACTURE AND INSPECTION OF AEROFOIL MODELS.

Fig. 1. MACHINING TWO-DIMENSIONAL AEROFOIL.

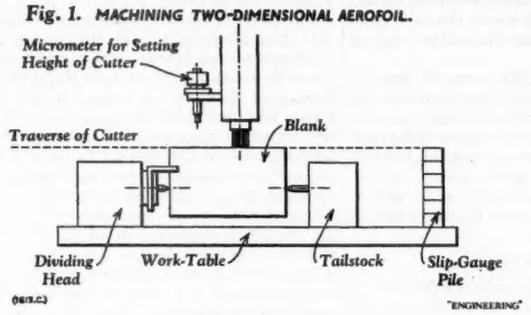


Fig. 2. MACHINING THREE-DIMENSIONAL AEROFOIL.

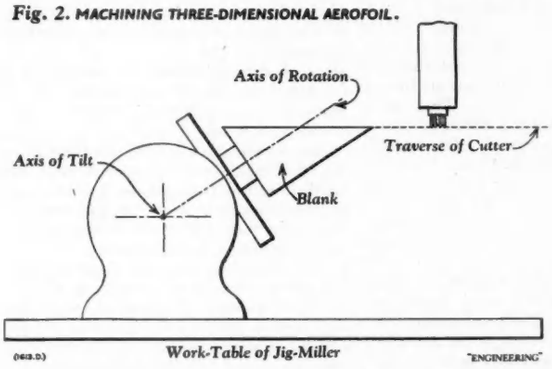
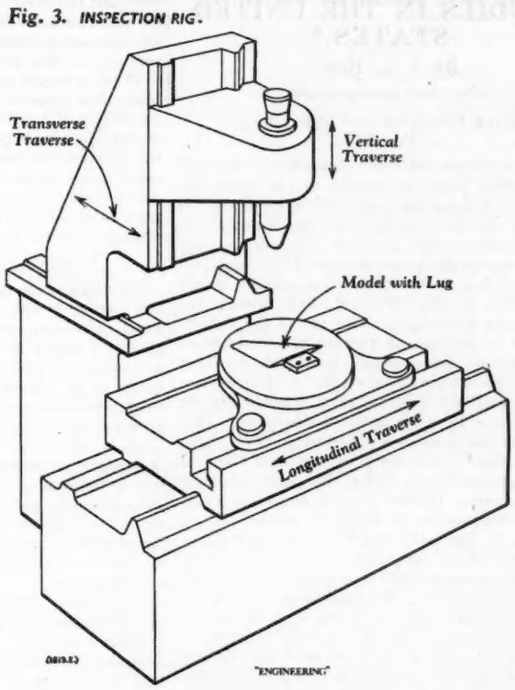


Fig. 3. INSPECTION RIG.



By the simple means of attaching a micrometer head to the milling head, in such a way that it can be made to register on a slip-gauge pile standing on the work-table, the cutter can be set to the previously-calculated height above the line of centres. An advantage of this arrangement, when making symmetrical models of the type shown in Fig. 4, is that, for any given height setting, two tangential planes symmetrically disposed with respect to the plane of symmetry can be cut by simple rotation of the blank. In this way, the two surfaces are generated together and distortion of the model due to cutting stresses is minimised.

To produce three-dimensional models, in addition to setting the cutter at the required height and rotating the blank to the correct azimuth for each tangential plane, it is necessary to tilt the line of centres to produce the required taper from root to tip. This tilt varies for each plane, but is easily calculated from the known geometry of the model required and the constants of the set-up. To obtain these tilts in addition to the precise rotation, one of the standard types of compound tables can be used, in which a rotary table can be inclined about an axis parallel to its face. For the work carried out at the National Physical Laboratory a type Pl-4 tilting rotary table, made by Société Génévoise, was available. Such tilting rotary tables have the necessary precision, but also the disadvantage that, when set up for this work, the head room and size of table required are more than are available on standard surface grinders or universal millers. For this reason, the production of three-dimensional models at the Laboratory has been carried out on a Bryant-Symmons jig-borer which, by the addition of a power feed to the work table, has been used as a jig-miller. Fig. 2 shows diagrammatically the arrangement for producing three-dimensional models.

INSPECTION.

It will be appreciated from the description of the method of manufacture that inspection of the model can proceed step-by-step with manufacture. It is merely necessary, after each plane is cut, to check the angular settings and then, by means of slip gauges and a dial indicator mounted on a stand, to check that the plane has been cut at the correct height from the base. An allowance has to be made for the small amount of metal that is removed in the final blending of the planes and the polishing

Fig. 4. MODEL AEROFOILS.

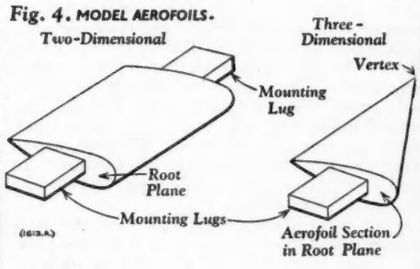
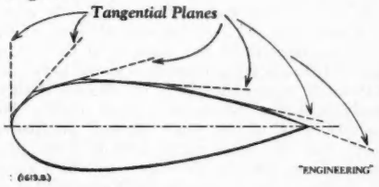


Fig. 5.



which is carried out by hand. That this allowance is sufficiently constant, and within the limits imposed for the model, was established by an independent method of inspection applied to the prototype models.

The measuring machine used for this inspection was a Société Génévoise universal measuring machine type MU 214B. This machine has a horizontal work-table which can be rotated precisely, and at the same time translated longitudinally. Above the work-table is mounted a microscope which sights on to the work-table and which can be traversed vertically and also transversely to the longitudinal movement of the work-table. Thus, the longitudinal movement of the work-table and the vertical and transverse movements of the microscope, all of which can be measured precisely, form a mutually perpendicular system of co-ordinate axes. To check the form of any section of a model the latter is mounted on the work-table by a large lug integral with the model and machined precisely flat and parallel to within 0·0001 in. during the initial preparation of the blank. Fig. 3 shows the arrangement for final inspection. The precision of the lug ensures that the plane of symmetry of the model is parallel to the plane of the horizontal traverses of the machine, and by adjustment of the rotatable table the base chord of the model is brought parallel to one of the horizontal movements. By suitable adjustment of the horizontal movements any point of the surface, along any specified section of the model, can be brought under the microscope. The vertical movement of the microscope is now adjusted until the surface of the model at the centre of the field of view is in focus. This is facilitated by using in the microscope a special objective which has a very small depth of focus and enables vertical settings of the microscope, on any particular point, to be repeated to within an accuracy of 0·0002 in. After completing measurements on one side of the model it is turned over and re-located. The precision of the mounting lug allows the measurements of the second surface to be precisely related to those made on the first surface. By comparing the measured half-thicknesses of the model with calculated nominal values, graphs giving the departure from the nominal form of each surface at specified sections may be obtained.

Since the production of the first trial models, which were solid, others have been made successfully with special features, such as pressure-plotting tubes, and a hinged tail-plane for flutter experiments. In addition, a roughing jig has been introduced which facilitates the early stages of manufacture, together with an adjustable height gauge to avoid the use of slip gauges.

The high precision of the form required naturally suggests that the models should be made by grinding, and the design of special fixtures to obtain the necessary rotation and tilt of a blank in the relatively small space under the wheel of a surface grinder is being pursued. It was learned after the completion of the initial trials by milling that Messrs. Rawlings and Partners, Kenilworth, Warwickshire, had independently, and with complete success, applied a similar technique to the manufacture of aerofoil models by grinding. With the experience gained from milling models and the benefit of discussions with Mr. Rawlings, it is proposed to grind hardened steel models at the Laboratory.

CHARTER SERVICE WITH "STRATOCRUISER" AND "CONSTELLATION" AIRCRAFT.—British Overseas Airways Corporation announce that, during the coming winter, some of their Stratocruiser and Constellation aircraft will be available for charter and special flights over the North Atlantic.

BRITTLE FRACTURE STUDIES IN THE UNITED STATES.*

By S. L. Hoyt.

(*Concluded from page* 188.)

Brittle Fracture and the "Match Point."

Brittle fracture will now be examined in the light of the match point as related to the important variables of temperature and rate of straining. If the stress conditions of the test bar simulate the service stresses—and no other test bar is truly adequate—a simple determination of the behaviour of that test bar at the service temperature should show whether the steel is suited to the application. That was the philosophy of the use of the double-width bar in the case of the forging cited above. In contrast to determining the match point at service temperature by altering the notch geometry, the more usual procedure is that of producing the brittle fracture by altering the temperature; that is the transition-temperature technique of changing the properties of the steel by lowering the test temperature until they match the stress condition of the test bar. In this way, if one steel has a transition temperature of 0 deg. F. and another of — 50 deg. F., the latter is held to be the tougher of the two. It is clear that, by using this technique, it is assumed that the stress pattern of the test bar approximates to the stress pattern of service closely enough to avoid any serious error of correlation. That assumption seems reasonably straightforward, yet it is not to be overlooked that the act of determining the transition temperature has altered the very properties that produce the profound change from ductile to brittle behaviour. How are we to know that the same superiority would hold for some higher temperature, such as 70 deg. F.? Without knowledge of the effect of temperature on the basic properties that control the behaviour, we cannot know.

Another point that has created interest in the United States is the effect of rate of straining on brittle fracture. In this connection, it is common to see the unqualified statement that brittle fracture may be produced by a high rate of straining. While it cannot be said that such a statement is incorrect, there is so much evidence to the contrary that it is definitely in need of proper qualification. One has only to consider the impact of a projectile on a steel plate to appreciate the ability of steel to deform plastically at even high velocities. The author also recalls viewing a riveted plate girder which had been hit by a projectile at a point about 2 ft. from the joint. The rivet holes had split open, but the plate proper was perfectly ductile to the blow of the projectile. Even the high strain rates during the fragmentation of a high-explosive shell result in ductile fractures.

The effect of strain rate has been treated at various times, but most successfully when associated with the effect of temperature. However, instead of a general unqualified relationship between the two variables, the strain rate is found to have a quantitative effect on the temperature of the match point. Thus, it is only over a restricted temperature range that "brittle fracture may be produced by a high rate of straining." For static loading (strain rate = 0) the shear strength at the match point (T deg.) is just sufficiently high in relation to the cohesive strength, to cause brittle fracture. At a higher temperature the bar would deform plastically, due to the temperature lowering the shear strength. However, if the strain rate is increased to some finite rate, 1, the shear strength is thereby increased and a new match point is established at some higher temperature = T_1. At a still higher strain rate, 2, the shear strength is increased still more and the match point comes at a still higher temperature, T_2. The quantitative relationship has been established by the De Forest brittle temperature technique and found to be a straight-line function between the log of the strain rate and the reciprocal of the absolute temperature of the match point. Actually, the effect of strain rate is relatively small; for uniaxial stress it has been shown that a 10,000-fold increase in strain rate raises the brittle temperature only 25 deg. F.

There is ample evidence, going back at least to 1894, that increasing the strain rate increases the ductility and toughness of steel. Increases of over 50 per cent. are reported and one may wonder how the general belief gained credence that high strain rates make metals brittle. The evidence is that such is true only for conditions in the vicinity of the match point, due to the effect of strain rate in raising the shear strength.

Manufacturing Variables.

The third phase of the work on brittle fracture in the United States covers the manufacture of the steel. This is an important and direct step to take, as was recently stated by D. P. Brown.* After reviewing the history of welded ships and discussing design and workmanship, he commented that the most positive approach to avoiding serious breaks in ships lay in the field of materials. That sentiment is also voiced in the United States as far as immediate measures are concerned. The specific aim is to produce structural-grade steel that will have adequate notch-toughness for the design and service conditions. Technically, the solution to the problem of producing a medium-carbon notch-tough steel is not difficult, as it has been shown that a killed steel made to fine-grain practice, and normalised, is superior in this respect. A good example is the normalised S.M.A. steel, which was developed many years ago by Herty and co-workers. A similar steel is the Grade C steel of the American Bureau of Shipping. Economically, however, this type of steel is at a disadvantage, and it is less well adapted to large-scale production than the semi-killed steel. In both Great Britain and the United States it has been recognised that improved notch-toughness can be secured by lowering the carbon and raising the manganese. In Britain, that principle finds expression as the Mn : C ratio, which should be kept at 3 or above. However, a constant strength level is to be tacitly assumed. In the United States, the principle is put into effect in the A.B.S. Grade B steel.

While many welded ships and structures have experienced fractures in service, it is also true that many more have withstood the same (or approximately the same) service satisfactorily, though made to the same specification for the steel. It is not out of the question, had the steel all been of the quality represented by the majority of the welded ships, that the overall performance would have been substantially improved. It is not known if there actually is such a difference in steel quality, but numerous tests of the then current production showed that the steel varied widely from high quality to low quality, as shown by the Charpy test. In this connection, from the National Bureau of Standards tests, we also have the important and statistically significant difference in notch toughness between the "end" plates and the "start" plates of fractured ships.

It is unfortunate that ships with good records have not been sampled, and tests made for information on the level of notch toughness that prevails in ships of good records to help to establish test specimens and methods that best simulate service conditions. Such information would give highly desired guidance to the costly research programmes now in progress on steel quality and manufacturing variables. About the best that can be done, in the absence of a correlation with service, is to attempt to avoid the quality of material that failed, and try to manufacture steel in the upper quality bracket.

The major formal research investigation being conducted on the effects of composition and manufacturing variables on ship-steel quality is that at the Battelle Memorial Institute for the Ship Structure Committee. The aim of this study is to untangle the effects of individual variables and ultimately to show how they combine to establish a given level of notch toughness. Some of this work has been published, and additional papers will be issued as phases of the work are completed. In the meantime, the author is privileged to include some of the findings here.

The steels of the investigation were usually made with two levels of C and Mn, which correspond to Grade A type (about 0·24 C and 0·45 Mn) and Grade B (about 0·20 C and 0·75 Mn) of the American Bureau of Shipping, and were of the semi-killed type. The variables included alloy, deoxidation, and impurity elements, and rolling and finishing temperatures or structure. In some of the test series, the composition and the extent and type of deoxidation went beyond the practice for Grades A and B. The notch toughness was determined by the transition temperature of the Navy-tear test and the keyhole Charpy test. For the former, it was the highest temperature at which one or more specimens of a group of four had under 50 per cent. ductile fracture. For the latter, it was read off the average temperature/energy curve at the 20 ft.-lb. level. This investigation has demonstrated the feasibility of using laboratory heats of semi-killed steel for studies of this kind. In structure and in performance, the laboratory heats are the practical equivalent of full-scale commercial heats.

The general effect of the findings is to support the idea that Grade B steel is more resistant to brittle fracture than Grade A. This means that, for the strength level of this ship steel, it is advantageous to lower the C and raise the Mn, and this, in turn, supports the idea of the 3 : 1 ratio of Mn to C. In discriminating between these grades, the tear test seems not to be so sensitive as the Charpy test. On the other hand, if ageing effects are involved, as with high N, the tear test is better. As a result of a large amount of testing the following relationships were developed by multiple correlation methods for ¾-in. plate, finish-rolled at 1,850 deg. F.:

Upper yield strength, lb. per square inch = 23,000 + (39,200 × per cent. C) + (7,200 × per cent. Mn); standard error = 1,500 lb. per square inch. Lower yield strength, lb. per square inch. = 20,700 + (39,800 × per cent. C) + (8,400 × per cent. Mn); standard error = 1,300 lb. per square inch. Tensile strength, lb. per square inch. = 30,800 + (104,000 × per cent. C) + (13,000 × per cent. Mn); standard error = 2,200 lb. per square inch. Elongation, per cent. = 38·2 − (32·6 × per cent. C) − (3·2 × per cent. Mn); standard error = 2·4 per cent. Tear-test transition temperature = + 17 + (330 × per cent. C) − (23 × per cent. Mn); standard error = 10 deg. F. Keyhole Charpy transition temperature = −19 + (349 × per cent. C) − (74 × per cent. Mn); standard error = 15 deg. F.

As expected, structure and ferrite grain-size were found to be significant, and when studying other variables it was necessary to correct for structure and strength or to hold them constant. The evidence is that an important lowering of the transition temperature can be obtained by rolling down to a finishing temperature which is below the customary level. Some of the tests showed about the same lowering of the transition temperature by finishing rolling at 1,650 deg. instead of 1,850 deg. F., as increasing the Mn : C ratio from 2 : 1 to 5 : 1 or from 3 : 1 to 7 : 1. Reducing the Mn : C ratio from 3 : 1 to 2 : 1 raised the tear-test transition temperature by at least 10 deg. F., while increasing the ratio from 3 : 1 to 5 : 1 lowered it by about 15 deg. F. This confirmed the findings of others that deoxidation elements usually lower the transition temperature first and then raise it. Apparently, they function first to fix the O and N and then as alloy elements. Silicon was found to be particularly effective in the Grade B steel and reduced the transition temperature from about 90 deg. F. for low silicon to about 50 deg. F. at 0·10 per cent. Between about 0·16 and 0·30 per cent. the transition temperature increased from about 30 deg. to 60 deg. F. Nitrogen was found to increase the tensile strength of both steels at the rate of 700 lb. per square inch for each 0·001 per cent. Its effect on the transition temperature was nearly 5 deg. F. for each 0·001 per cent., uncorrected for strength. Its effect on the Charpy-test transition temperature was about half that amount.

In this way, data for semi-killed ship steel, and to some extent for fully-killed steel, have been

* Paper presented at the Conference on Brittle Fractures in Steel, organised by the West of Scotland Iron and Steel Institute and held in Glasgow on May 15, 1953. Abridged.

* "Observations on Experience with Welded Ships," *The Welding Journal*, vol. 31, page 765 (1952).

obtained on the quantitative effects of C, Mn, Si, P, S, N, Al, Ti, Zn, and V, finishing temperature, and ferrite grain size. Additional work will attempt to determine the combined effect of two or more variables such as occurs in practice. It is hoped that out of this will come explanations for the variations in notch toughness of commercial semi-killed ship-plate steel. If so, the steel mills will be in much better position to produce steel of the upper level of notch toughness and it should be possible to write more realistic specifications.

A logical extension of the programme on semi-killed steels will deal with the fine-grained type of A.B.S. Grade C steel. Experience with this type of steel shows that it differs in some characteristics from the open types and, furthermore, that it too must be carefully controlled in manufacture if uniformity in notch toughness and weldability is to be obtained. It appears that weldability should be included in this phase of the investigation, because the fine-grained steel will be used in heavier sections and at the more critical locations. To avoid sacrificing strength, there will be a tendency to increase the carbon and possibly the manganese. Since both of these elements increase the tendency to under-bead and other types of cracking, especially in heavy sections, more careful work will be needed if more or less standard welding methods are to be used. In an earlier study at Battelle it was demonstrated that manganese banding is particularly objectionable if a high level of weldability is to be maintained.

In addition to the research programme mentioned above, several other studies are under way which help to illuminate this general field. From the empirical nature of this field, it is essential to secure a correlation between laboratory tests and service performance. The example of the failed forging was cited—but not all correlations are as simple as that. An intermediate field is covered by centrally-notched wide-plate tests. They show a drop in the nominal breaking load with increase in width until the normal yield strength is approached. In the hatch-corner tests at the University of California, this calculated stress fell well below the yield strength.

More recently, Hoeltje and Newmark have suggested a treatment of the notched-plate results to secure a correlation with small laboratory specimens and large structures. For this they use a parameter which is the ratio between the notch radius and the net cross-sectional area as the definition of the stress field. The log of this ratio plots as a straight line with the log of the brittle strength, with a slope of 0·115. The position of the line is fixed by a constant, K, which depends on the steel. When the transition temperature of the wide plates is plotted against the same parameter, once the ratio is less than a critical value—that is, the width is above a critical value for a given notch radius—there is no significant change in the brittle temperature. For greater values, the transition temperature falls. This suggests that structures with small values of the ratio tend to fail in brittle fashion when at or below some temperature which depends on the steel. A failure would occur at a relatively low nominal stress, in the presence of a notch. The parameter can also be used in setting up tests to correlate with large structures.

At the Naval Research Laboratory, use has been made of the explosion bulge technique to study crack initiation and propagation. The behaviour of the steel is examined in the presence of a crack which forms in a deposit of hard weld-metal. Resistance to crack initiation is given by the ability of the steel to deform without that crack spreading. Below a certain temperature, the "ductile transition," the test plate fractures with no deformation. Therefore, the danger from the spreading of a brittle fracture in a structure which contains a crack or a defective weld depends on the ductile transition temperature of the steel.

Tests of rimmed and semi-killed steel from welded merchant ships show that they have ductility transitions at temperatures at which the Charpy V-notch test runs less than 10 ft.-lb. This agrees reasonably well with the N.B.S. tests, which showed that the plates in which fracture started had failed in service at about the temperature at which the Charpy V-notch value was 10 ft.-lb. However, this ductility transition comes at the 15 ft.-lb. temperature for fully-killed steel. The measure of the resistance to propagation of a crack is taken as the extent of development of a shear lip. This is zero at the ductility transition and increases with temperature to about 0·70 in. for plates 1 in. in thickness. Above this temperature, brittle fracture is not possible, even with explosive loading. However, the temperature at which the shear lip is about 0·20 in. is taken as the practical limit for the propagation of brittle fracture in welded structures. This correlates with tests of the "end" plates.

When these data are correlated with the Charpy tests, it is seen that neither the keyhole nor the V-bar has so severe a notch effect as that of the test, and this difference is accentuated for fully-killed steels. The correlation with the Schnadt "coheracic" bar, with the sharp pressed notch, was good, using the 2 Mkg. per square centimetre value. This was true for both killed and unkilled steels. A virtue of this investigation is that it gives a better definition of the stress conditions in large structures. Thus, when the brittle fractures of service are duplicated in laboratory tests which use specimens of known notch geometry, it seems reasonable that the stress systems in the two cases must have been effectively similar. That was basically the reason for those early tests with the double-width Charpy bar. Some recent work at the Battelle Memorial Institute tends to confirm this viewpoint.

Another point to which much attention is paid, and which still needs clarification, is the interpretation of fracture appearance. While there is no difficulty with the coarser features, it is still true that a metal can deform substantially and yet show no evidence of such a change under the microscope. By then the metal will have absorbed considerable energy, and yet a brittle fracture will have the cleavage appearance. The centre of the tension test-bar is an exaggerated example.

It was stated earlier that welding produces a monolithic structure, with certain consequences. That, of course, is not the only thing it does. It also produces a very important engineering material which, significantly, comes at strategic places where its properties and characteristics exert a profound influence on the behaviour of the structure. It also produces the joint, which includes the heat-affected zone. In a negative capacity it may also provide cracks and defects which, under appropriate service conditions, may lead to brittle fracture of the steel.

Both the Naval Research Laboratory and the Battelle Memorial Institute have shown the desirability of using higher strength weld metals, though when tested separately they may not have superior properties as compared to low-strength weld metal. The heat-affected zone has given rise to an inconsiderate amount of weldability testing and speculation, unless or until it can be shown that such a hard zone, when crack-free, actually is responsible for premature brittle failures. The weld metal, on the other hand, is being recognised more and more as a very important material of construction. Possibly the least understood factor of brittle fracture is that of "locked-up stresses." With the failure of the Schenectady, locked-up stresses were played up strongly as the prime cause of failure, even to the point of disregarding the other possible causes. A large-scale study negated this notion, and attention was then directed to workmanship, design and steel. On the other hand, it does not seem reasonable to ignore the presence of these stresses, and they are now receiving attention.

71-MVA 301-KV TRANSFORMER FOR CANADA.—The first of four 71-MVA 301-kV single-phase transformers for the "Alcan" project of the Aluminium Co. of Canada, Ltd., Kemano, British Columbia, was dispatched from the Hollinwood factory of Messrs. Ferranti, Ltd., on Tuesday, August 4. These transformers, which are the first to be manufactured in this country for so high a voltage, are to be installed 400 miles north of Vancouver, some 300 ft. below ground, in cubicles hewn out of the rock. The same firm are shipping three 37-MVA 275-kV transformers for the other end of the line at Kitimat, where the alumin-production plant will be installed.

ANNUALS AND REFERENCE BOOKS.

Table of Arctan x.

National Bureau of Standards Applied Mathematics Series 26. The Superintendent of Documents, United States Government Printing Office, Washington 25, D.C., U.S.A. [Price 1.75 dols.]

THIS is a re-issue of Mathematical Table 16, prepared by the New York Mathematical Tables Project and first published in 1942. During the ensuing interval, no errors were reported in the functional values, though several misprints were noted in the argument; these have now been corrected. Values of inverse functions can, of course, be extracted from existing tables of direct functions, but much time and labour is usually saved when separate tabulations of the inverse functions are available. The arc tangent is the inverse circular function most widely encountered in pure and applied mathematics, and its principal value may be defined by the integral $\arctan x = \int_0^x \frac{du}{1+u^2}$, where, since $\arctan(-x) = -\arctan x$, only positive values of x need be considered. The lack of a comprehensive table of this integral in radians is met in the present volume by a tabulation of the function to 12 decimal places over the following range of the independent variable x—0 (0·001) F (0·01) 50 (0·1) 300 (1) 2,000 (10) 10,000. The intervals between successive arguments have been so chosen that interpolation to 12 decimals can be made with the aid of central second differences, which are tabulated beside the main entries. Following the main table are three auxiliary tables, the first of which gives values of the coefficients $E_2(p) = \frac{p(1-p^2)}{6}$, $F_2(p) = \frac{q(1-q^2)}{6}$ ($p + q = 1$), required in Everett's formula, by the use of which interpolation can be carried out to within 1·5 units in the 12th decimal place. The second auxiliary table gives values of $\frac{1}{12}p(1-p)$, and the third provides for the conversion of radians to degrees and vice versa. Professor W. G. Bickley, of the Imperial College, London, contributes a foreword; and an introduction, by A. N. Lowan, deals with properties of the function, direct and inverse interpolation, approximate arguments, method of computation and procedure for checking the tables. It concludes with a bibliography of tables of $\tan x$, $\arctan x$ and related functions, together with notes of errors in certain of the items listed.

Laundries and Laundry Requisites, 1953.

Twelfth edition. Anglo-Scottish Press, Limited, 67, Fleet-street, London, E.C.4. [Price 7*s.* 6*d.*]

THIS annual directory of an industry which now engages the attention of an important section of the engineering industry consists of three parts. The first is a buyers' guide, listing all the principal firms who supply launderers, dyers and cleaners with plant, machinery and sundries. The second part is a directory of laundries, arranged under the counties in which they are situated, and is supplemented by a separate list of hospitals and other institutional laundries; and the third is a directory of dyers and cleaners. There are two indexes, one of the advertisers, whose announcements occupy a considerable number of the 462 pages, and the other referring to the classifications in the buyers' guide.

Guide to the Coalfields, 1953.

Edited by R. H. WALKERDINE, B.Sc., Assoc.M.I.Min.E., and C. TREHARNE JONES, B.Sc., Assoc.M.I.Min.E. The Colliery Guardian Company, Limited, 30 and 31, Furnival-street, London, E.C.4. [Price 20*s.*]

IN general arrangement, this useful reference book has undergone little alteration since its first appearance five years ago; nor is there any obvious reason why it should, as the sections follow a logical and convenient sequence which covers adequately not only the nationalised coal-mining industry, but also the small mines which remain outside of it. For some time, the detailed maps of the various coalfields have been in process of revision, and this has been completed in the present edition and the maps numbered on a uniform system throughout. They are now numbered separately for each of the eight Divisions, and these numbers are reproduced on the key maps. The particulars given for each mine are notably full, including the address and telephone number, the type of coal mined, the names of the manager and under-managers and details of their qualifications, number of men employed above and below ground, etc. The indexing also is worthy of remark, separate indexes being given of mines, personal names and owners of "licensed" mines, in addition to the general index and an index to advertisers.

ECONOMIC UTILISATION OF COPPER-BASE ALLOYS.*

Acute shortages of non-ferrous materials having emphasised the need to avoid waste of valuable raw materials, Technical Sub-committee T.S. 38 of the Technical Council was appointed in March, 1951, with terms of reference (after slight amendment) as follows: "To investigate the properties obtainable in copper-base alloy castings, having regard to the economical utilisation of metals." As consideration of the object proceeded, it became clear that, with the economic utilisation of metals as the important subject, the properties obtainable in castings constituted only part of the problem, and other factors such as the standardisation of alloys and methods of production were of equal importance. The terms of reference have, therefore, been interpreted in the broadest sense, with the emphasis on the economical utilisation of metals. The properties of copper-base alloy castings are being investigated, but this work is not ready to be reported.

In considering the economic utilisation of metals in the copper-alloy casting industry, there are essentially two directions of approach—from the user's and from the foundryman's point of view. Broadly stated, the steps which the engineer can take are to design his castings in consultation with the foundry technician, so that they are suitable for maximum output in production; to select a standard alloy compatible with both service and production requirements; to keep factors of safety to a minimum in order to conserve metals, and, in those instances where it is reasonable to do so, to use alloys of higher strength to the same end. By taking these steps, the engineer user would be helping himself with regard to delivery, price, quality and metal available for the manufacture of his requirements. The foundryman, for his part, should take steps to improve his output and the quality of his castings so that the designer can safely use the lowest possible safety factors in his designs. This involves improvement in existing technique and the development of new techniques.

In connection with the reduction of safety factors, attention has been focused on the scarcity of information on the subject of actual properties in copper-alloy castings: this, of course, is one of the main subjects for consideration and a survey has been made of existing knowledge. Attention has been drawn to the need for the selection of standard alloys; examination has been made of alloys currently in use and the question of standardisation has been considered.

The report therefore is divided into four main parts: the first two consider the steps which can be taken by the foundryman and the user, respectively, with advantage to both, the next deals with the properties obtainable in castings, and the last with the standardisation of alloys. These are followed by a statement of the conclusions reached. In most respects, the reference to the foundryman concerns both the die-casting and the sand-casting sides of the foundry. Similarly, from the user's point of view, it is frequently economic for him to use die-castings rather than sand castings, and appropriate reference is made in the text of the report to the use of die-castings.

Foundry Matters.

The foundryman is already well aware of the shortage and high price of metals, a state of affairs which will continue. It will, therefore, be clear to him that it is in his interest to do all that he can to assist the designer in keeping casting sections to a minimum. For this to be reasonable, it is necessary for the foundryman to sell his castings by piece rather than by weight. In many foundries this is already being done, and it is clearly to the advantage of the other foundries to follow this course in order to be competitive. By the improvement of present casting methods and by the development of new techniques he must produce castings of regular high quality and he must increase his output by the use of improved methods and by attention to foundry layout. Another important factor is to reduce the number of alloys used in the foundry to a minimum. In this way, supplies of metal can be made to go further and increased output can be obtained.

In addition to the betterment of existing methods, many new techniques have been developed in recent years for improvement in casting quality and for more economic production. Usually these techniques have specific fields of application, and although some of them require special plant or equipment, others can be adopted in most foundries.

In the centrifugal casting field, extensive use was made, during the war, of stack-moulding methods for parts required in large quantities for war equipment, such as fighting vehicles. Phenomenal savings were shown annually in materials, man-hours and money. These methods are being applied to-day in this country, particularly by the tractor manufacturers.

The lost-wax process, previously used in statuary, dental and surgical casting, and in the jewellery trade, was applied during the war to the investment casting of turbine blades. It is now being used on a large scale for the production of castings in materials which are difficult to machine or fabricate, for intricate castings, for high standards of surface finish, and for dimensional accuracy. It is a specialised process requiring special plant. There has been, however, the development of the use of sillimanite and similar refractories bonded with silicon ester for the manufacture of semi-permanent moulds, and developments with partially-hydrolysed silicon esters in this country have contributed considerably in this field by the simplification of techniques. These moulds can be used for alloys which are not normally "die-castable" and for the die-casting of alloys where the quantities do not warrant the manufacture of expensive metal dies. High dimensional accuracy can be achieved when required. Much use can be made of plaster of Paris for moulds and cores where dimensional accuracy or quality of surface finish is desired. If any of these methods which save machining can be offered, metal is saved.

A new process developed in Germany before and during the war is now being widely experimented with in this country and overseas: it is the "C" process. This makes use of a shell mould made of sand bonded with a plastic. Many advantages are offered, particularly increased output and closer dimensional accuracy than is possible with normal sand-casting methods. This is probably the least-specialised of the processes mentioned, and a field into which more and more of the work currently made by sand casting will be directed. The basic principles of this process apply to sand-foundry production and could lead to very considerably improved foundry economy in the manufacture of castings of smaller sizes.

To achieve maximum output, a foundryman should be constantly on the look-out for methods of improving his layout and for opportunities to introduce suitable mechanisation. Proper technical control, consistent with the size of the plant and the scope of its output, is essential in the modern foundry. There is much of great value on these subjects in the British Productivity Team's report on "The Brassfoundry." There are chapters on planning, foundry layouts, aids and mechanisation, patternmaking techniques, moulding, running and casting methods, the core-shop, melting methods and technical control. Probably one of the most important sections is that concerned with the use of matchplates; a method is given for the economic production of patternplate equipment for the machine moulding of relatively small batches of castings.

Die-Castings.

The die-casting foundry has been somewhat restricted in the production of copper-base alloys owing to the high melting points of these alloys and the consequent wear of the dies. This has now been largely overcome by the introduction of die steels improved in their resistance to thermal shock. The most commonly-used alloys for die-casting are the brasses covered by British Standard 1400 B4-C and B5-C, the high-tensile brass HTB 1-C and the aluminium bronzes AB1-C and AB2-C. The last named of the aluminium bronzes is used only when the properties of this alloy are especially required. Developments have included new die dressings to obviate the build-up of oxides on brass die-casting dies. Leaded brasses are being die-cast to facilitate machining, and silicon brasses to prolong die life.

Die design and running methods are important in order to keep down the weight of metal used in relation to the weight of useful castings made. There already exists in the die-casting field a close relationship between designer and foundryman because of the particular necessity for the design to suit the die-casting technique. There is still, however, the need for a study to be made of the actual strength of castings so that sections can be reduced to a minimum.

So that the designer may reduce sections, the foundrymen, both of sand and die-castings, must endeavour to learn as much as possible about the properties obtainable in castings: data should be collected and, where the numbers involved justify it and where proper collaboration with the designer can be established, castings should be sectioned for the preparation of test-pieces. This will enable suitable modifications to be made where necessary to the mutual benefit of the designer and the foundryman.

In years gone by, it has been the policy for the foundryman to sell alloys of his own composition, the formulæ of which have been closely-guarded secrets. This undoubtedly served its commercial purpose in times less enlightened than to-day. Alloys suitable for a specialised application fall within a small range of composition and in most instances foundries would supply a similar alloy whatever name might be given to it: there might be slight variations in compositions but without significant influence upon service performance. Commercial advantages are to be obtained, not by small variations in the composition of an alloy, but by skill and experience in the selection of the most suitable type of alloy for a specialised application and by the ability to achieve a high standard of quality with economic methods of manufacture. There is no justification for discouraging the use of standard alloys, as standardisation would clearly be to the benefit of the foundry, bearing in mind that special alloys sometimes have to be used for particular applications. Undoubtedly, the smaller the number of alloys used in the foundry the greater the economy in both man-hours and materials. When standard alloys are used, ingots can be bought to specification, ensuring consistency in composition—a particular aid to the smaller foundry.

User Matters.

It does not need to be emphasised that the availability of metals is a matter of importance to the user of the castings. It follows that he has a prime interest in economy in the use of metals for the main purpose of ensuring the supplies of his requirements. If, at the same time, the steps which he takes to economise improve delivery times and reduce prices, these are added incentives. By suitable design, and by the correct choice of alloys, increase in output can be obtained in the foundry and a saving made in the amount of metal used. These advantages are best achieved by collaboration between the designer and the foundry technicians at an early stage.

In the aircraft industry it has always been necessary to obtain castings of the least possible weight yet strong enough to meet structural requirements. For this reason, it has been necessary to design components suitable for production as high-quality castings and there has followed the necessity of knowing the mechanical properties in important parts of castings. The aircraft designer, therefore, has long been aware of the need for consultation with the foundryman and metallurgist at an early stage of his design in order to achieve the desired results. This has been an influence in the light-alloy industry which has not obtained in the copper-alloy field. It is now necessary, however, to reduce to a minimum the amount of metal used in copper-alloy castings. With lighter castings, the cost would be lower and deliveries improved. For this, it is necessary, with a given design of casting in a

* Report of Sub-Committee T.S.38 of the Technical Council of the Institute of British Foundrymen, presented at the 50th Annual Conference of the Institute, held in Blackpool from June 16 to 19, 1953. Abridged.

selected suitable alloy, to know what properties can be expected in the various sections of the casting. For instance, it has been found possible for the Admiralty to re-design valve-box castings to take advantage of the greater strength and corrosion-resisting properties of aluminium bronze. After re-designing the valve box, weights were considerably reduced.

In the selection of an alloy, the first consideration must clearly be the service which it has to perform. If this permits a choice of alloys, then a proper balance must be struck between the economic use of materials and the facility with which the castings can be produced. If the selection of an alloy of high-tensile strength permits a considerable reduction in section, and thereby a saving in material, this alloy should be used, unless for design reasons it is unsuitable for the economic production of the castings. The need for a proper understanding with the foundryman on this matter cannot be over-emphasised. For example, on many occasions, the choice by a designer of the wrong type of gunmetal for pressure-tight castings has caused considerable scrap in the foundry, delays in delivery and high prices. It is important that, whenever possible, a British Standard alloy should be used so as to reduce the number of alloys in use in the foundry to a minimum: it is clear that this would increase output with advantageous effect on price and delivery.

When the quantities required of a particular design justify the expense of a die, and provided that an alloy suitable for the service requirements can be economically die-cast, then die-castings should be used. There are limitations, in that die-castings can only be made satisfactorily in aluminium-bronze, ordinary or high-tensile brass, and if over about 15 lb. they are not normally made in copper alloys, although castings of suitable design have been made of over 20 lb. in weight. The mechanical properties in die-castings are superior to those in sand castings and closer dimensional tolerances can be maintained with a consequent saving in machining. Collaboration between the designer and the die-caster is essential, so that the designs are suitable for manufacture in dies and so that the sections are suitable for the production of sound castings. Although it is preferable that quantities should be of the order of one to two thousand minimum, batches as low as 500 castings are sometimes accepted. The gunmetals and tin bronzes do not lend themselves to die-casting, because of their hot-short characteristics, and can only be used when very simple forms are required. Aluminium-bronze, B.S. 1400 AB2, can be die-cast, but it causes rapid deterioration of the die and, unless the properties of this alloy particularly are required, it should not be specified; aluminium-bronze B.S. 1400 AB1 is very suitable for die-casting.

This section is intended primarily for the designer in the user's works, but it might be well to include a note concerning inspection. B.S. 1376, "A Code of Procedure for Copper-Base Alloy Castings," treats the inspection of castings rationally according to the services which they are required to perform. Unfortunately, there are many official inspecting bodies having special codes of procedure differing in requirements for similar products. This frequently involves small batches, and the casting of unnecessary numbers of test-pieces, generally adversely affecting economy in production effort. Every effort should be made to facilitate and co-ordinate inspection procedures in the foundry both by the private user and the larger public and national concerns.

Strength of Castings.

In the foregoing sections, the important reasons for keeping casting sections to a minimum have been given. In order to be able to design castings with minimum sections it is necessary that the designer should have knowledge of the properties which he can expect to obtain in the important parts of the castings. Reference to material specifications will indicate the properties which can be expected in separately-cast test-bars. It is important to make it clear that separately-cast test-bars are cast solely to prove the quality of the metal. They are cast under standardised conditions so that, from melt to melt, consistent results should be obtained. These conditions do not represent those obtaining in the various parts of the casting and it follows that the properties cannot be expected to be the same. Cast-on test-bars serve no useful purpose either to prove the quality of the metal—as they are not cast under standardised conditions—or to indicate properties of other parts of the castings. The properties in the various sections in the casting in a given alloy are affected by such factors as wall-thickness, changes in section, and the influence of chills, feeding heads and ingates. None of these local conditions is simulated in separately-cast or cast-on test-bars, and it follows that in order to find out the mechanical properties in a particular design of casting it is necessary to prepare test-bars from the important regions of prototype castings.

As has been explained in an earlier section, the preparation of test-pieces from castings for the purpose of investigating their strength with a view to the reduction of sections to a minimum is a procedure to which aircraft designers in particular, and light-alloy foundrymen have been accustomed. Unfortunately, little information available on the subject refers to copper-alloy castings. The technical committee of the Association of Bronze and Brass Founders conducted an investigation in this field, the results of which were published by the Institute of British Foundrymen in 1949. A number of castings in phosphor-bronze (sand and chill-cast), gunmetals, aluminium-bronze and high-tensile brass in current production in various foundries were selected and sectioned, and complete data covering production conditions recorded. Tensile, hardness and impact tests were conducted on the prepared specimens, pressure tests being made on the castings where this was applicable. For economic reasons, that programme of work could be conducted only on a limited scale, and the results, therefore, serve only as an indication of what can be expected and to draw attention to the need for a more extensive survey.

To obtain general information of the type described and envisaged by this sub-committee is a prolonged process, and, for economic reasons and in the time available, results are not at present ready for publication. Opportunity should not be lost by all concerned in everyday practice to make such tests which would serve an immediately useful purpose to the designer and the foundryman. Data collected would become an important guide to the designer, but, for any specific casting which might be at all complicated, it would still be necessary to investigate that particular casting, made by the technique intended for mass production, in order to learn about its properties. It is also in the interest of the designer to consider whether the alloy which is selected is suitable for the economic production of the castings. For example, B.S. 1400 G1 (88/10/2) gunmetal is frequently selected, as it is thought by the designer to have higher mechanical properties than B.S. 1400 LG2 (85/5/5/5) gunmetal. This is true in the case of separately-cast test-bars, but, because of the founding characteristics, it is doubtful whether the properties in a casting are significantly different. In the case of pressure-tight castings, in some instances it is found practically impossible to make them in 88/10/2, while they might be made easily in 85/5/5/5.

Standardisation of Alloys.

The sub-committee realised the large number of alloys which were being used in the foundry industry and the notable effect which this had on both production and metal economy. As the copper-alloy casting industry has developed, individual foundries have produced their special alloys with proprietary names, recommending them for specific applications. At the same time, large users have drawn up their own specifications for materials. The result has been a large number of alloys, many with similar basic compositions but differing sufficiently to demand special foundry charges and segregations in the stores, and the foundry has had to handle many times more alloys than necessary. The British Standards Institution have introduced standard specifications, but by no means the majority of users have adopted them; many foundrymen still sell their proprietary alloys, and users continue to demand alloys to their own specifications.

The sub-committee has obtained a survey of the number of alloys used in the industry, through the Association of Bronze and Brass Founders and the British Bronze and Brass Ingot Manufacturers' Association, and the information returned by these bodies has been summarised. It is interesting to note that the figures returned by the A.B.B.F. and B.B.B.I.M.A. are of the same order. While it is a matter for some agreeable surprise that the respective figures for alloys used to British Standard Specifications are 85·1 per cent. and 76·3 per cent., the figures which are really important are the 14·9 per cent. and 23·7 per cent. for alloys other than to the British Standards. In the A.B.B.F. report, these have been broadly classified, but undoubtedly under each individual heading there are many specifications, and the necessity for the retention of these demands particular attention. Foundrymen should take all possible steps to encourage their customers to use equivalent British Standard alloys wherever they exist and users should always endeavour to find suitable standard alloys rather than select non-standard ones.

Reverting to the figures for the British Standard alloys used, in each case, LG2 (85/5/5/5) is shown to be used considerably more than any other; the high figure (16·18 per cent.) for HTB1 (30-ton high-tensile brass) in the A.B.B.F. report is probably influenced by returns from marine-propeller manufacturers. The low figures for some of the alloys in the British Standard range led to consideration as to whether these alloys could be completely dropped, and other B.S. 1400 specifications recommended to replace them. The sub-committee considers that the attention of the British Standards Institution should be drawn to the following points:

(1) There are five brass specifications in B.S. 1400, two of which are die-casting alloys, and three sand-casting alloys; three brasses are quite sufficient. (2) There are three leaded bronzes, LB1 (76/9/0/15), LB2 (80/10/0/10) and LB3 (85/10/0/5); these could be condensed into one or two specifications. (3) G2 (88/8/4) gunmetal and LG1 (83/3/9/5) leaded gunmetal are very little used, and more suitable alternatives are readily available; they could, therefore, be discarded. (4) Silicon bronze, SB1, is very little used; it could easily be replaced with an alternative standard alloy, and it is difficult to handle in the foundry; in view of these points it should be omitted from the specification. (5) The HTB3 high-tensile brass has well recognised limitations and is little used. On the other hand, an alloy of this type finds definite application, and consideration should be given as to whether it could be replaced by an alternative alloy.

Her Majesty's Services have already realised the need for reducing the number of specifications in use, and a committee has been set up representing the various Service departments to prepare a schedule of specifications, co-ordinating those now in use with the equivalent British Standard specifications. The Institute's sub-committee has been privileged to examine the draft of this schedule and to offer comments. It is hoped that this work will be completed soon so that it may be properly taken into consideration in the review of the British Standard 1400 which is due in the near future.

The British Railways Executive have already given consideration to the same question, and at about the time when this sub-committee was starting its work, notification was issued by the Railway Executive of five alloys which they specified as replacing the thirty-seven alloys previously used. The sub-committee feel that the reduction in the number of alloys has probably been overdone; for example, LG2 (85/5/5/5) has been completely omitted, the only leaded gunmetal being LG3 (86/7/5/2) which is to be specified in future for wagon bearing castings, replacing the original Railway Clearing House specification (82/3·5/11·5/4) which represents a very considerable proportion of the output of a number of large foundries; this does not appear to be an economic step. Three of the five alloys conform to B.S. 1400, and two do not; none is specified by B.S. 1400 references. It is thought that the brazing-metal specification will be brought into line with the British Standard specifi-

cation B.6, in course of preparation. There is no equivalent to the B.R.E. alloy containing 5 per cent. of tin, with 26 per cent. of lead and 1·5 per cent. of nickel; it would be helpful to consider whether the nearest British Standard LB1 (76/9/0/15) would serve the purpose equally well, or, alternatively, whether a new British Standard is required.

CONCLUSIONS.

There will be complete agreement that there should be economy in the use of metal and in production effort in the foundry in the interest of both the user and the foundryman.

The foundryman's attention has been directed to the following points: the use of special techniques—to improve quality, to reduce machining allowances, and save metal and machining time. The use of British Standard alloys—to decrease stocks and increase the economic utilisation of raw materials. The need for knowledge of the properties obtainable in castings—to help the designer to achieve economy. Foundry control—to improve quality and to reduce scrap.

The user's attention has been drawn to: the need for collaboration with the foundryman at the design stage—to improve the quality of castings and to increase productivity. The need for knowledge of the strength of castings—to save metal. The need to use British Standard alloys—to reduce costs and to gain the other general advantages of standardisation. The need to reduce sections or use stronger alloys whenever possible—to economise in metal. The desirability of using die-castings when suitable—to save machining and for economy in production.

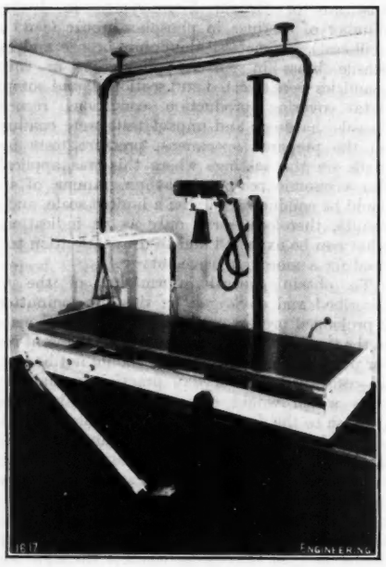
Underlying most of these points is the need for knowledge of the properties obtainable in the castings and the choice of the most suitable alloy, having regard to the service requirements and economy in production. Work is still in hand on the properties of castings; the necessity has been emphasised for obtaining knowledge on the strength of castings by user and foundryman and for British Standards to be used as much as possible. The former is considered to be a matter for learning by broad experience and not a question which can be answered by any specific investigation.

AWARDS TO GRADUATES AND STUDENTS OF THE INSTITUTION OF CIVIL ENGINEERS.—The Council of the Institution of Civil Engineers announce that Miller Prizes have been awarded to the under-mentioned graduates and students of the Institution for papers read during the 1952-53 session, namely, Mr. R. M. Birse, for "Engineering Education"; Mr. Douglas Collier, for "Investigations into the Stability of a Masonry Screen Wall"; Mr. Kenneth Mackenzie, for "The Lining of Errochty High-Pressure Tunnel"; and Mr. J. A. S. Watson, for "Summer Work on the Daer Water Scheme Pipelines," all delivered before the Edinburgh and East of Scotland Association. The other prizes were awarded to Mr. M. E. McKee, for "Design of Proposed New Sludge Jetty for Belfast Corporation," presented to the Northern Ireland Association; Mr. M. J. Hill, for "First Stage Road Works of a New Approach Road to Swansea," presented to the South Wales and Monmouthshire Association; and Mr. M. F. Maggs, for "Road Traffic Engineering with Reference to Some Recent Bristol Surveys," presented to the South-Western Association.

OIL REFINERY FOR BOMBAY, INDIA.—On Trombay Island, Bombay, the construction of a new 20*l.* million oil refinery for the Shell group has now commenced, with completion scheduled for early 1955. The new plant is to have an annual capacity of two million tons of crude oil, which will be brought by tankers from Middle East fields, and its output will supply a large proportion of India's requirements of petroleum products. In order to provide the necessary shipping facilities, a new oil terminal installation is being built by the Bombay Port Trust on Butcher Island, from where the crude oil will be pumped three miles through submerged pipe-lines to the new refinery. After refining, which will include the processes of crude distillation, vacuum distillation, catalytic cracking, and also bitumen manufacture and packing, the products will be pumped to the existing distributing installations in the Bombay area, and also back to Butcher Island for shipment. The project is being financed by a new company, the Burmah-Shell Refineries, Limited, which has been incorporated in India with an authorised capital of Rs. 250 million, and erection is being carried out by the Luminus Company, New York.

TILTING TABLE FOR RADIOGRAPHY.

X-RAY equipment recently introduced by Messrs. Watson and Sons (Electro-Medical), Limited, East-lane, North Wembley, has been designed to provide facilities for fluoroscopy and radiography in the horizontal position from below, the movements of the tube and screen being synchronised. It can also be used for overtable radiography with or without a Potter-Bucky diaphragm; for vertical fluoroscopy and radiography; for teleradiography at distances up to 6 ft.; and for stereoscopic radiography. A view of the equipment arranged for overtable radiography is given in the accompanying illustration. For vertical fluoroscopy the table top is raised by operating a spring-loaded handle; when the point of balance is reached, pressure on a second handle moves the top into the vertical position. To restore the top from the vertical to the horizontal it is only necessary to release a foot-operated catch, when a combination of counterweight and spring-loaded piston moves it down until it engages with a second catch. Practically silent operation is ensured by the provision of rubber buffers.



The table is equipped with a motor-driven oscillating Potter-Bucky diaphragm, which requires no setting or time adjustment. This diaphragm, which consists of lead slats placed perpendicular to the path of the X-rays, allows the primary rays to reach the film, but eliminates the secondary radiation. It incorporates a Lucidex grid with a ratio of 10 to 1 and a cassette tray with a self-centring clamp, which will accommodate all sizes of cassette from 6½ to 17 in. It can be moved the whole length of the table top, being retarded at the foot end by spring buffers. The fluorescent screen, which measures 14 in. by 14 in., is supported on a counterweighted carriage and can be adjusted to heights varying from 7 to 20 in. above the table top, thus allowing free access for the patients and giving adequate room for lateral radiography. The screen can be moved for a distance of 3 ft. along the length of the table top and 8 in. laterally. The movements of the screen, which can be locked in any position, are controlled by a lever. A holder for cassettes up to 14 in. by 17 in. is provided for use when the screen is vertical. The square leaf diaphragm with lead shutters is fitted at the lower left-hand corner of the fluorescent-screen frame and can be swung out of the path of radiation when tele-radiography is to be undertaken.

The tube stand is supported on a base which runs on a double floor track and can be locked in any position. The cross-arm supporting the X-ray tube is counterweighted and, while it has an adequate range of travel across the table top, does not protrude behind the back of the tube stand. The stand can therefore be placed close to the wall when space is restricted. The vertical range of movement allows a maximum focus/film distance of 48 in. above the table top, while the tube can be rotated through 180 deg. about the axis of the cross-arm and 30 deg. on either side of the long axis. The tube column itself can be rotated on its base through 90 deg. for lateral radiography across the table top. As regards protection, the primary beam can be confined to the area of the film or fluorescent screen by means of the tube diaphragm.

BOOKS RECEIVED.

The Braking Performance of Motor Vehicles and Brake Testing. By DR. H. J. H. STARKS. Road Research Technical Paper No. 26. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 2*s.* net.]

Report of the Chemistry Research Board with the Report of the Director of the Chemical Research Laboratory for the Year 1952. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 4*s.* 6*d.* net.]

The Principles and Practice of Surveying. Vol. II. *Higher Surveying.* By PROFESSORS CHARLES B. BREED and GEORGE L. HOSMER. Seventh edition. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 7 dols.]; and Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 56*s.* net.]

The Atomisation of Liquid Fuels. By PROFESSOR E. GIFFEN and DR. A. MURASZEW. Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 36*s.* net.]

Statistics of the Iron and Steel Industry of the United Kingdom for 1952. British Iron and Steel Federation, Steel House, Tothill-street, London, S.W.1. [Price 7*s.* 6*d.*]

The British Electrical and Allied Industries Research Association. Technical Report No. A/T 138. *The Permanent Effect of Water on Varnished Coils.* By H. R. HEAP. [Price 7*s.* 6*d.*] No. G/T 279. *Flame-proof Electrical Apparatus: Re-Assessment of the Values of Statistical Maximum Safe Gap on the Basis of the Integral Curve of a Normal Distribution.* By C. E. R. BRUCE. [Price 6*s.*] Supplement to Technical Report G/T 279. [Price 7*s.* 6*d.*] No. L/T 268. *Stabilization of Impregnated-Paper Capacitors: Pilot Scale Tests with Azobenzene.* By H. F. CHURCH. [Price 12*s.*] No. L/T 279. *The Torsional Vibrations of Long-Chain Molecules.* III. By B. SZIGETI. [Price 6*s.*] No. O/T 10. *Examination of a Defective Creosoted Pole After Remedial Treatment by the Cobra Process.* By D. N. SMITH. [Price 7*s.* 6*d.*] Offices of the Association, Thorncroft Manor, Dorking-road, Leatherhead, Surrey.

Department of Technology of the City and Guilds of London Institute. Report, 1952. [Price 2*s.* 3*d.* post free.] *Examination Results,* 1952. [Price 2*s.* 3*d.* post free.] *Regulations and Syllabuses, Mechanical Engineering and Allied Subjects,* 1953-54. [Price 2*s.* 3*d.* post free.] Office of the Department, 31, Brechin-place, London, S.W.7.

Productivity Team Report. Milk Utilisation. Report of a British Productivity Team which visited the United States of America in 1952 to study the utilisation of milk. British Productivity Council, 21, Tothill-street, London, S.W.1. [Price 5*s.* post free.]

S.S. Ocean Vulcan Sea Trials. The Forces Acting on the Ship at Sea. The Admiralty Ship Welding Committee Report No. 8. H.M. Stationery Office, Kingway, London, W.C.2. [Price 35*s.* net.]

Introduction to Elliptic Functions with Applications. By F. BOWMAN. English Universities Press Limited, St. Paul's House, Warwick-square, London, E.C.4. [Price 12*s.* 6*d.* net.]

Strength and Elasticity of Materials and Theory of Structures. Solutions to Examination Questions of the University of London. Vol. II. Part One (External) B.Sc. (Engineering), 1937-1950. By DR. W. H. BROOKS. Macdonald and Company (Publishers) Limited, 16, Maddox-street, London, W.1. [Price 15*s.* net.]

The Design of Dams. By PROFESSOR A. BOURGIN. Translated by FRANK F. FERGUSSON. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price 45*s.* net.]

Physics. Vol. 1. By L. S. POWELL. *Part I: Mechanics. Part II: Heat. Part III: Properties of Matter and Sound.* Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price, three parts bound in one volume, 21*s.* net; each part separately, in cardboard covers, 5*s.* net.]

Ministry of Transport. Railway Accident. Report on the Accident which Occurred on 4th April, 1953, *at Plessey Road Public Level Crossing, Newsham, in the North Eastern Region British Railways.* H.M. Stationery Office, Kingsway, London, W.C.2. [Price 6*d.* net.]